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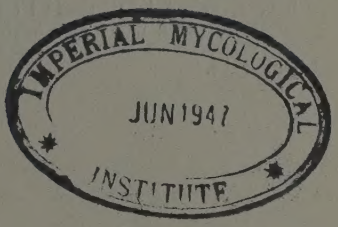

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MATHÉMATIQUES

SUR UN INVARIANT DES TRANSFORMATIONS ASYMPTOTIQUES

Par S. BACHVALOFF

(Présenté par N. N. Lusin, de l'Académie, le 16. XI. 1943)

1. Considérons un couple de congruences stratifiables L_1, L_2 dont l_1 et l_2 sont les rayons correspondants; on peut joindre à chacune des L_j une famille de ∞^1 surfaces $\sum_j$ (stratifiantes) de sorte que les plans tangents aux surfaces de chaque famille le long d'un rayon de cette famille passent par le rayon correspondant de l'autre famille.

On sait que deux surfaces stratifiantes quelconques de l'une des familles sont des transformations asymptotiques d'une surface arbitraire de l'autre famille.

Les transformations asymptotiques (donc, les couples stratifiables) sont définies par les équations suivantes (1)

$$\overline{M_j} = \overline{M_0} + [\overline{N_j}\overline{N}] \qquad j = 1, 2 \tag{1}$$

$$\overline{M_3} = \overline{M_0} + \psi\,[\overline{N_2}\overline{N_1}] \tag{2}$$

$$\overline{N_3} = \overline{N_0} + \psi\,[\overline{N_2} - \overline{N_1}] \tag{3}$$

Dans les équations (1), (2), (3) $\overline{M_0}$, $\overline{M_3}$ sont les rayons-vecteurs des points des surfaces stratifiantes de l'une des familles; $\overline{M_1}$, $\overline{M_2}$ — les rayons-vecteurs des points des surfaces de l'autre famille, et $\overline{N_j}$ $(j = 0, 1, 2, 3)$ — les vecteurs normaux aux surfaces M_j vérifiant les conditions

$$(\overline{N_j}^2)^2 = -\frac{1}{K_j}, \qquad j = 0, 1, 2, 3$$

où K_j est la courbure de Gauss de la surface M_j. La fonction ψ est déterminée à une constante arbitraire près par deux équations aux dérivées partielles. A chaque valeur de cette constante il correspond une surface stratifiante M_3.

2. Soit $\overline{\tau}$ le vecteur perpendiculaire aux droites M_0M_3, M_1M_2; $2a$ — la distance minimale entre ces droites et θ — l'angle qu'elles forment.

Au moyen des équations (1), (2), (3) on détermine

$$\overline{\tau} = [\overline{M_0M_3},\ \overline{M_1M_2}] = ([\overline{N_2}\overline{N_1}]\,[\overline{N_3}N_0]) = (\overline{N_0} - \overline{N_3})(\overline{N_0}\overline{N_1}\overline{N_2}) =$$

$$= (\overline{N_1} - \overline{N_2})(\overline{N_0}N_2\overline{N_3}) \tag{4}$$

$$2\alpha = \frac{(\bar{N}_0\,\bar{N}_2\,\bar{N}_1)}{|\bar{N}_2 - \bar{N}_1|} \tag{5}$$

$$\sin\theta = \frac{|\bar{N}_3 - \bar{N}_0| \cdot (\bar{N}_0\,\bar{N}_2\,\bar{N}_1)}{|\overline{M_0M_2}| \cdot |\overline{M_1M_2}|} \tag{6}$$

On tire de (5), (6)

$$\left(\frac{2\alpha}{\sin\theta}\right) = \frac{|\overline{M_0M_3}|}{|\bar{N}_3 - \bar{N}_0|} \cdot \frac{|\overline{M_1M_2}|}{|\bar{N}_2 - \bar{N}_1|}. \tag{7}$$

Or, il résulte de (1), (4) que l'on a

$$\frac{|\overline{M_1M_2}|}{|\bar{N}_2 - \bar{N}_1|} = \frac{|[\bar{N}_2 - \bar{N}_1, \bar{N}_0]|}{|\bar{N}_2 - \bar{N}_1|} = |\bar{N}_0| \cdot \sin(\bar{N}_0, \bar{\tau})| = \left|\frac{\cos\alpha_0}{\sqrt[4]{K_0}}\right|$$

où α_0 est l'angle du plan tangent à la surface M_0 avec la perpendiculaire commune des rayons l_1, l_2. On détermine d'une manière analogue le second facteur dans (7).

Ainsi nous avons

$$\left(\frac{2\alpha}{\sin\theta}\right)^4 = \frac{\cos^4\alpha_0}{K_0} \cdot \frac{\cos^4\alpha_1}{K_1} \tag{8}$$

Comme $\frac{2\alpha}{\sin\theta}$ est déterminé par deux rayons correspondants des congruences stratifiables et ne dépend pas des paramètres définissant les surfaces stratifiantes des familles $\sum_1$, $\sum_2$, on voit que

$$\frac{\cos^4\alpha_0}{K_0} = I_0 \tag{9}$$

reste invariable quand on passe d'une surface stratifiante de la première famille à une surface arbitraire de la même famille et

$$\frac{\cos^4\alpha_1}{K_1} = I_1 \tag{10}$$

reste invariable quand on passe d'une surface stratifiante de la seconde famille à une surface arbitraire de la même famille.

3. Signalons quelques propriétés des couples de congruences stratifiables:

a) Il suit de l'équation (9) que l'on a $K_0 = \frac{1}{I_0}\cos^4\alpha_0$; donc, K_0 possède la valeur maximale pour $\alpha_0 = 0$ et décroît quand α_0 croît de 0 à $\pi/2$.

b) Si les surfaces M_0 et M_3 ont une même courbure $K_0 = K_3$, on a $\alpha_0 = \alpha_3$; ainsi les plans tangents aux surfaces M_0, M_3 forment des angles égaux avec la perpendiculaire commune des rayons l_1, l_2.

c) Si $\alpha_0 = \alpha_3$, on a $K_0 = K_3$.

Université Lomonossoff
à Moscou.

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LITTÉRATURE CITÉE

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MATHEMATICS

ON THE CRITERIA OF NON-SIMPLICITY OF GROUPS

By A. P. DIETZMANN

(Communicated by O. J. Schmidt, Member of the Academy, 31. XII. 1943)

W. Burnside (1) and J. Schur (2) gave a method for mapping a finite group homomorphically on to a subgroup of the Abelian quotient group by one of its subgroups. Some criteria of non-simplicity of finite groups were obtained by this method.

In the present paper we indicate a method which gives a homomorphic mapping of a subgroup of an arbitrary group Γ on to a subgroup of the Abelian quotient group by another subgroup of Γ. In this way we establish new criteria of non-simplicity of the subgroup considered as well as of Γ itself.

As particular cases we obtain the method mentioned above, some results due to W. Burnside and J. Schur, and also the criteria of non-simplicity of finite groups recently obtained by several authors with the aid of the Burnside and Schur method.

Let H and Q be subgroups of the group Γ such that the decomposition of Γ by duple modulo (H, Q)

$$\Gamma = HG_1Q + HG_2Q + \ldots + HG_kQ \qquad (1)$$

contains a finite set * of equivalent by duple modulo (H, Q) systems of elements.

Denote by $\mathfrak{N}$ an invariant subgroup of H containing the commutant of H and satisfying the condition

$$H \cap G_iQG_i^{-1} \subset \mathfrak{N} \qquad i = 1, 2, \ldots, k \qquad (2)$$

where $G_1, G_2, \ldots, G_k$ is a complete system of residues by duple modulo (H, Q) in (1).

Let further $\overline{N}$ be the normalizer of the subgroup Q in Γ; N, a subgroup of $\overline{N}$; ν, an element of N, and

$$G_i\nu = h_i(\nu)\overline{G}_iq_i, \qquad i = 1, 2, \ldots, k, \qquad (3)$$

where $h_1(\nu), h_2(\nu), \ldots, h_k(\nu)$ are elements of H; $q_1, q_2, \ldots, q_k$ elements of Q; the sequence $\overline{G}_1, \overline{G}_2, \ldots, \overline{G}_k$ contains all the elements $G_1, G_2, \ldots, G_k$ which are denoted differently, because they may be arranged in another order.

We note that, although the representation of $G_i\nu$ in the form (3) for any given $i = 1, 2, \ldots, k$ is not necessarily unique, the product $h_i(\nu)\mathfrak{N}$ is the same coset irrespective of the choice of the elements $h_i(\nu)$ so obtained, which follows from the condition (2).

* But H and Q are not supposed to be of finite index under Γ.

Theorem 1. *By putting in correspondence to every element* $\nu \in N$ *the product* $h_1(\nu)\,h_2(\nu)\,\ldots\,h_k(\nu)\,\mathfrak{K}$ *as its «image» in* $H/\mathfrak{K}$, *we obtain a homomorphic mapping of the subgroup* N *on to a subgroup of the Abelian quotient group* $H/\mathfrak{K}$. *The product* $h_1(\nu)\,h_2(\nu)\,\ldots\,h_k(\nu)\,\mathfrak{K}$ *does not depend on the choice of the residues* $G_1, G_2, \ldots, G_k$ *by duple modulo* (H, Q) *in the decomposition* (1). *If* $h_1(\nu)\,h_2(\nu)\,\ldots\,h_k(\nu)\,\mathfrak{K} \neq \mathfrak{K}$, *then* N *possesses an invariant subgroup* N_1 *containing the commutant of* N *and not containing* ν, *which consists of all those elements of* N *that are carried into the unit element of the quotient group* $H/\mathfrak{K}$. *In particular, if* N *and* $H/\mathfrak{K}$ *are finite groups, then the order of* N_1 *is a multiple of the greatest divisor of the order of* N, *relatively prime to the order of the quotient group* $H/\mathfrak{K}$.

The proof of this theorem is based on the condition (2) and the relation (3).

Choosing the residues $G_1, G_2, \ldots, G_k$ in (1) suitably, we can obtain a formula for the mapping that gives the «image» $|\nu|$ in $H/\mathfrak{K}$ of the element ν. of N. Namely, for every element ν of N the decomposition of the group Γ by duple modulo (H, Q) can be represented in the form

$$\begin{aligned}
\Gamma = {} & HQ + H\nu Q + \ldots + H\nu^{\alpha_1 - 1} Q + \\
& + \ldots\ldots\ldots\ldots\ldots + \\
& + Hg_t Q + Hg_t \nu Q + \ldots + Hg_t \nu^{\alpha_t - 1} Q + \\
& + \ldots\ldots\ldots\ldots\ldots + \\
& + Hg_u Q + Hg_u \nu Q + \ldots + Hg_u \nu^{\alpha_u - 1} Q
\end{aligned} \tag{4}$$

Then the image $|\nu|$ in $H/\mathfrak{K}$ of the element ν has the form

$$|\nu| = (\nu^{\alpha_1} q_1)(g_2 \nu^{\alpha_2} q_2 g_2^{-1}) \ldots (g_u \nu^{\alpha_u} q_u g_u^{-1})\,\mathfrak{K}. \tag{5}$$

Here α_i $(i = 1, 2, \ldots, u)$ is the least positive integral power of the element $g_i \nu g_i^{-1}$ that belongs to the system $Hg_iQg_i^{-1}$ (g_1 is the unit element of Γ); $\alpha_1 + \alpha_2 + \ldots + \alpha_u = k$, where k is the number of distinct systems in the decomposition (4) of Γ by duple modulo (H, Q); $q_1, q_2, \ldots, q_k$ are elements of the subgroup Q. If ν is an element of finite order, then α_i $(i = 1, 2, \ldots, u)$ are divisors of the order of ν.

We now note some results obtained with the aid of Theorem 1 and formula (5).

Theorem 2. *Let* $G_1, G_2, \ldots, G_k$ *be a complete system of residues of the group* Γ *by duple modulo* (H, Q); $\mathfrak{K}$, *an invariant subgroup of* H *containing the commutant of* H *and satisfying the condition* (2); N, *a subgroup of the normalizer of* Q *in* Γ. *Suppose that the intersection* $H \cap N$ *contains an element* ν *of finite order prime to* k, *which does not belong to* $\mathfrak{K}$ *and possesses the property that for any integer* $\beta \geqslant 1$ *and for any* $i = 1, 2, \ldots, k$ *at least one element of the system* $G_i \nu^\beta Q G_i^{-1}$ *included in* H *belongs to* $\mathfrak{K}\nu^\beta$. *Then* N *possesses an invariant subgroup which contains the commutant of* N *and does not contain* ν.

Theorem 3. *Suppose that the decomposition of the group* Γ *by duple modulo* (H, Q) *consists of* k *systems. Let* $\mathfrak{K}$ *be an invariant subgroup of* H *containing the commutant of* H *and satisfying the condition* (2); N *be a subgroup of the normalizer of* Q *in* Γ. *Suppose further that the subgroup* H *coincides with its normalizer in* Γ *and the intersection* $H \cap N$ *contains an element* ν *not belonging to* $\mathfrak{K}$ *and having the property that, for any integer* $\beta \leqslant k$, ν^β *belongs to* Q, *whenever a subgroup conjugate to* H *and different from* H *contains elements of the system* $\nu^\beta Q$. *Then* N *possesses an invariant subgroup which contains the commutant of* N *and does not contain* ν.

Theorem 4. *Suppose that* $G_1, G_2, \ldots, G_k$ *is a complete system of residues of* Γ *by duple modulo* (H, Q); k *is not divisible by a prime* p; Q *is a periodic subgroup of* Γ, *whose elements are of orders not divisible by* p; $\mathfrak{K}$ *is an invariant subgroup containing the commutant of* H *and satisfying the condition* (2).

Suppose further that N is a subgroup of the normalizer of Q in Γ and the intersection $H \cap Q$ contains an element of order p^ω such that $\mathfrak{K}$ contains no power of it, except the unit element of the group. If for any $i = 1, 2, \ldots, k$ at least one element of the system $G_i \nu Q G_i^{-1}$ included in H belongs to $\mathfrak{K}\nu$, then N possesses an invariant subgroup which contains the commutant of N and does not contain ν.

Theorem 5. *Suppose that the decomposition of the group Γ by duple modulo (H, Q) consists of a finite number of systems; Q is a periodic subgroup of Γ whose elements are of orders not divisible by a prime p, and the subgroup H coincides with its normalizer in Γ; $\mathfrak{K}$ is an invariant subgroup of H containing the commutant of H and satisfying the condition (2). If N is a subgroup of the normalizer of Q in Γ, the intersection $H \cap N$ contains an element ν of order p^ω such that $\mathfrak{K}$ contains no power of it, except the unit element of the group, and every subgroup conjugate to H and different from H contains no elements of the system νQ, then N possesses an invariant subgroup which contains the commutant of N and does not contain ν.*

Supposing the group Γ to be finite and taking the unit element of Γ instead of Q, we can deduce from Theorems 1—5 some criteria for the non-simplicity of finite groups, in particular, the results of W. Burnside[3], G. Frobenius[4], S. Tchounikhin[5] and V. Turkin[6].

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ASTRONOMY

SECULAR PARALLAXES OF FAINT STARS AS DEDUCED FROM PULKOVO CATALOGUE DATA ON PROPER MOTIONS IN KAPTEYN AREAS

By A. N. DEICH

(Communicated by G. A. Shajn, Member of the Academy, 2.XI. 1943)

1. The secular parallaxes of faint stars have been determined on the basis of their proper motions as obtained at Pulkovo with a normal astrograph. Counts of stars to the 15 th magnitude in 74 Kapteyn north areas have given a total number of 18 000. The probable error of the annual proper motion is $\pm 0''.005$. In general, the catalogue is free from magnitude error.

2. The coordinates of the solar apex for the stars of the catalogue have proved to be

$$A = 284°.8 \pm 2°.4 \quad \text{and} \quad D = +35°.8 \pm 0°.7$$

This is a marked deviation from its standard position:

$$A = 270° \quad \text{and} \quad D = +30°$$

deduced for bright stars both from the meridian proper motions and from radial velocities. The difference in the position of the apex as referred to bright (above the 7th magnitude) and to faint stars may hardly be accounted for by the presence of systematic errors in the proper motions. Nor seems the reason to lie in the supposed increase of the ratio of high velocity stars as one gradually passes to smaller and smaller magnitudes, since the position of the apex shows no systematic variation either with increase of the apparent magnitude of stars (above 7) or with decrease of their proper motions. The more probable explanation is therefore that there should exist a local star stream comprising mainly bright stars. To estimate its dimensions from the mean parallaxes of stars of the 7th magnitude, such a star cluster may measure about 300 parsecs in the diameter.

3. The conversion of relative proper motions into absolute motions was effected through fundamental stars whose average number was about 10 in each area. The absolute proper motions of these stars had been derived by Hins at Leiden as a result of comparing new observations on meridian circles, made by several different observatories, with the old A. G. catalogues and some others. The proper motions had been reduced to the PGC system of Boss. It was brought into evidence by the investigation of the present author that the proper motions as deduced by Hins with reference to right ascension, are fraught with a systematical error which is in the nature of a magnitude error. This error is inherent in the old observations. Therefore a replication of Hins' catalogue in the future will permit the available photographs of proper motions to be used for determining, besides secular paral-

laxes, the correction to constant precession and the coefficients of Galactic rotation. In the present work, however, the direct differences between Leiden-Pulkovo data on the mean proper motions of the fundamental stars in each area were preliminarily corrected for the inaccuracy of Newcomb's precession and for Galactic rotation on the basis of the available data from other authors. The differences thus corrected should represent the components of the parallactic displacement of the reference stars on the photographic plate with respect to which the motions of the other stars are measured, plus the influence of the systematic error above-mentioned. In determining the secular parallax of the reference stars and the value of the systematic error equations of the following form were used

$$\Delta\left(\frac{h}{\rho}\right)\sin\lambda + \Delta\mu_x \sin\chi = v$$

The secular parallax of the reference stars is designated $\Delta(h/\rho)$, because, strictly speaking, this value is merely a correction to the relative secular parallaxes of stars of different apparent magnitude which make them assume their absolute values. The reference stars were selected within a range of 12.5 to 13.5 photographic magnitudes (mean 13.2), all the proper motions exceeding $0''.02$ per year being, as a rule, excluded. The investigation has shown that within the measurement error the secular parallax of the reference stars is constant for all Galactic latitudes, with the exception perhaps of a narrow zone about the mean value of the 30° latitude, where its magnitude was found to be somewhat less. This may be explained by the presence of absorbing matter in low Galactic latitudes and by the conditions imposed upon the selection of the reference stars. Therefore the equations of condition for all areas could be solved jointly, and this gave

$$\Delta\left(\frac{h}{\rho}\right) = 0'',0085 \pm 0''.0008$$

$$\Delta\mu_x = 0.0056 \pm 0.0008$$

As it seemed that the declination component of the proper motion might be regarded as free from systematic error, the equation used contained only this component

$$\Delta\left(\frac{h}{\rho}\right)\sin\lambda\cos\chi = \mu_\delta$$

In this case the secular parallax of the reference stars proved to be $\Delta\left(\frac{h}{\rho}\right) = 0''.0088$. Nor had it shown a systematic variation with Galactic latitude, thus fully supporting the foregoing conclusion.

With regard to the systematic error $\Delta\mu_x$ we must take it into account that the observations used by Hins refer to epochs differing by 45 years. We then shall obtain a magnitude error of $0^s.017$.

As the mean photographic magnitude of the fundamental stars in Kapteyn's areas is 9.5, and that of PGC about 5.5, the error found refers to an interval of four stellar magnitudes.

4. The secular parallaxes of stars have been calculated for three Galactic belts, from 0 to ±25°, from ±25 to ±49°, and from ±50 to ±84°. In the third group the data comprise only northern latitudes. The apparent difference between the parallaxes in the northern and southern Galactic hemispheres is entirely accounted for by the systematic error mentioned in the preceding paragraph. The data given in Table 1 are smoothed values of the absolute secular parallaxes of stars in three Galactic zones, irrespective of the sign of the Galactic latitude. The stellar magnitudes are given in the international photographic system.

Table 1

m	Secular parallaxes			MacKormak—Pulkovo		
	$\bar{b}=12°$	$\bar{b}=40°$	$\bar{b}=68°$	$\bar{b}=12°$	$\bar{b}=40°$	$\bar{b}=68°$
9.5	0″.0250	0″.0295	0″.0323	—0″.0064	—0″.0076	—0″.0053
10.5	220	245	247	69	75	32
11.5	155	172	190	36	36	14
12.5	115	130	150	17	20	5
13.5	97	116	130	14	24	6
14.5	82	108	119	10	30	11

Comparisons with the data obtained in MacKormak's observatory show that our parallaxes are larger, and the difference grows with the decrease of stellar magnitude. This is certainly owing to a different interpretation of large proper motions. This secular parallaxes of MacKormak are underestimations because of the introduction of smaller weights in the case of large mean proper motions in the areas. It may be remarked that the course of the secular parallax, as well as that of its logarithm, does not vary linearly with the stellar magnitude, and slopes more gently upon the transition to very faint stars.

5. By comparing the secular parallaxes obtained by the present author with the mean parallaxes derived by Oort from the proper motions of stars in the Kapteyn areas, as given in Radcliff's catalogue, it was possible to obtain the space velocity of the Sun with respect to stars of different magnitude by means of the formula

$$v_{\odot}=4.74\left(\frac{h}{p}\right)/\pi$$

His mean parallaxes Oort had obtained from comparing proper motions with radial velocities. In his investigation too large proper motions were not omitted from consideration. From Table 2 it is seen that the velocity of the Sun increases with the apparent stellar magnitude, being at first near to the standard value 20 km/sec. in medium and high latitudes. In lower latitudes, ranging from 0 to 25° the velocity obtained for the Sun is too high, although its increase with the stellar magnitude has the same character. It seems that in low latitudes the mean parallaxes as-obtained by Oort are underestimated, possibly as the result of overestimation of radial velocities of faint stars.

Table 2

m	$v_{\odot}$ in km/sec.		
	$\bar{b}=12°$	$\bar{b}=40°$	$\bar{b}=68°$
10.5	25.6	21.9	19.7
11.5	25.5	18.9	18.3
12.5	28.4	19.4	20.2
13.5	31.1	24.1	24.6
14.5	28.2	29.8	29.1

6. In the Galactic latitudes ranging from 0 to ±25° the secular parallaxes may differ from one another in different areas, according as the latter are in the «light» or «dark» regions of the Milky Way. In the «dark» regions Galactic absorption must be stronger, and this is bound to increase the main value of the secular parallaxes of stars of the same magnitude. Out of 34 areas, 19 were «light» and 15 «dark», the mean number of stars up to the fifteenth photographic magnitude being 1384 and 657 per one square degree, respectively. The determination of mean secular parallaxes was carried out in the same way as in the general case, and the corrections for the transition to absolute parallaxes proved to be equal:

for «light» areas $\Delta\left(\frac{h}{\rho}\right) = 0''.0074 \pm 0''.0019$

for «dark» areas $\Delta\left(\frac{h}{\rho}\right) = 0.0103 \pm 0.0018$

Further analysis has shown that the average absorption of «dark» areas with respect to «light» areas is equal to 0.5 stellar magnitude. Assuming that the absorption difference is proportional to the difference between the logarithms of the number of stars in the areas, and that in the case of the lightest areas the absorption can hardly exceed 0.3 stellar magnitude, one arrives at the conclusion (based on the solution of certain equations of stellar statistics) that the coefficient of total absorption is approximately one stellar magnitude per kiloparsec.

7. In 74 areas there were found 484 stars to the fifteenth photographic magnitude with proper motions $\mu \geqslant 0''.095$ per year. In the whole sky the number of such stars in probably not less than 66000. As the Galactic latitude increases, so does also the number of stars with large proper motion. Their mean spectral type, according to the determinations made by Schwarzmann at Bergedorf, is G 5. As all these stars seem to be located at a nearly equal distance from us and the spectral type for the apparent magnitudes ranging from 11 to 15 is on the average the same, such stars may possibly be 2—3 magnitudes lower than the main series, thus increasing the dispersion of absolute values for yellow dwarfs.

8. The discussion of 70 binaries discovered from the common proper motion of their components has led to the conclusion that for every 33 stars there is one double star. This statistics relates to wide double stars. The semi-major axis of such binaries is approximately equal to 4000 astronomical units, and the mean period of revolution is about 180 000 years. The dispersion of semi-major axes is allowable within a range of 800 to 40 000 astronomical units. The distribution density of satellites around central stars follows the law $\rho \sim r^{-3.4}$. Thus, the number of satellites decreases with increasing distance r instead of remaining constant, as would be the case if we were to assum ethe Epic law $\rho \sim r^{-3}$. The difference ΔM between the absolute values of the components is in general equiprobable up to $\Delta M = 7$.

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MÉCANIQUE

SUR LES TRANSFORMATIONS DES ÉQUATIONS DES SYSTÈMES NON-CONSERVATIFS

Par B. V. BULGAKOV

(Présenté par L. S. Letbensohn, de l'Académie, le 17. X. 1943)

1. Application de l'intégrale de Helmholtz. Le principe de Hamilton sous la forme que lui a donné Helmholtz (1) est appliqué immédiatement aux systèmes non-conservatifs, si l'on introduit un terme complémentaire contenant la forme de Pfaff

$$\delta A = \sum_j Q_j \delta q_j \tag{1}$$

qui exprime le travail virtuel des forces non-conservatives Q_j $(j = 1, \ldots, n)$. On considère alors l'expression

$$\delta J = \delta \int_{t_0}^{t_1} \Big(\sum_j p_j \dot{q}_j - H \Big) dt + \int_{t_0}^{t_1} \delta A \, dt \tag{2}$$

et, en calculant les variations, on voit que la relation

$$\delta J - \Big[\sum_j p_j \delta q_j \Big]_{t_0}^{t_1} = 0 \tag{3}$$

ou

$$\int_{t_0}^{t_1} \Big[\sum_j (\dot{q}_j \delta p_j - \dot{p}_j \delta q_j) - \delta H + \delta A \Big] \, dt = 0 \tag{4}$$

équivaut à $2n$ équations du mouvement

$$\frac{dq_j}{dt} = \frac{\partial H}{\partial p_j}, \quad \frac{dp_j}{dt} = -\frac{\partial H}{\partial q_j} + Q_j, \tag{5}$$

$$j = 1, \ldots, n$$

Si l'on impose la condition supplémentaire que la somme $\sum p_j \delta q_j$ disparaisse pour $t = t_0$ et pour $t = t_1$, la relation (3) prend la forme usuelle $\delta J = 0$.

2. Transformations canoniques. Introduisons des nouvelles variables u_j, v_j au moyen d'une transformation canonique. On sait qu'une telle doit satisfaire à la condition

$$\sum p_j dq_j = \sum_j v_j du_j + H_1 dt + d\Omega \tag{6}$$

où $d\Omega$ est une différentielle exacte. Pour les variations on a la condition analogue

$$\sum_j p_j \delta q_j = \sum_j v_j \delta u_j + \delta\Omega \tag{7}$$

En désignant

$$H' = H - H_t \tag{8}$$

$$\delta J' = \delta \int_{t_0}^{t_1} \Big(\sum_j v_j \dot{u}_j - H' \Big)\, dt + \int_{t_0}^{t_1} \delta A\, dt \tag{9}$$

on obtient

$$\delta J = \delta J' + \Big[\delta\Omega \Big]_{t_0}^{t_1}$$

et, en vertu de (3) et de (7)

$$\delta J' - \Big[\sum_j v_j \delta u_j \Big]_{t_0}^{t_1} = 0 \tag{10}$$

De même qu'au paragraphe précédent cette relation équivaut à $2n$ équations

$$\frac{du_j}{dt} = \frac{\partial H'}{\partial v_j} - V_j, \quad \frac{dv_j}{dt} = -\frac{\partial H'}{\partial u_j} + U_j, \tag{11}$$

$$j = 1, \ldots, n$$

où les U_j et les V_j se déterminent aisément comme les coefficients de la forme δA exprimée en variables nouvelles:

$$\delta A = \sum_j (U_j \delta u_j + V_j \delta v_j) \tag{12}$$

La forme (11) des équations du mouvement est un peu plus générale que (5) et elle n'est plus altérée par les transformations canoniques ultérieures, bien qu'alors les rôles des coordonnés et des impulses que les deux séries des variables jouaient dans le système naturel en général se confondent.

3. Transformations générales. Supposons maintenant que l'on fait subir aux variables dépendantes une transformation générale

$$q_j = q_j(z_1, \ldots, z_{2n}, t), \quad p_j = p_j(z_1, \ldots, z_{2n}, t), \tag{13}$$

$$j = 1, \ldots, n$$

où les $z_s (s = 1, \ldots, 2n)$ sont les variables nouvelles. Calculons les dérivées $\dot{q}_j$, $\dot{p}_j$ et les variations δq_j, δp_j et introduisons les crochets de Lagrange

$$[u, v] = -[v, u] = \sum_j \Big(\frac{\partial q_j}{\partial u} \frac{\partial p_j}{\partial v} - \frac{\partial q_j}{\partial v} \frac{\partial p_j}{\partial u} \Big) \tag{14}$$

en entendant par u, v deux variables quelconques de l'ensemble $z_1, \ldots, z_{2n}, t$; la relation (4) devient

$$\int_{t_0}^{t_1} \sum_r \Big\{ [t, z_r] + \sum_s [z_s, z_r] \dot{z}_s \Big\} \delta z_r\, dt + \int_{t_0}^{t_1} (-\delta H + \delta A)\, dt = 0$$

ce qui équivaut aux équations

$$\frac{\partial H}{\partial z_r}+[z_r, t]+\sum_s [z_r, z_s]\frac{dz_s}{dt}=Z_r, \tag{15}$$

$$r=1, \ldots, 2n$$

les Z_r désignant les coefficients de la forme δA, exprimée en variables z_r:

$$\delta A=\sum_r Z_r \delta z_r \tag{16}$$

Dans le cas particulier d'un système conservatif ($\delta A\equiv 0$) les équations (15) se réduisent à celles qui ont été considérées par M. H. Andoyer (²).

4. Application au calcul des perturbations; variation des constantes. Supposons maintenant que l'on sache intégrer les équations

$$\frac{dq_j}{dt}=\frac{\partial H^*}{\partial p_j}, \quad \frac{dp_j}{dt}=-\frac{\partial H^*}{\partial q_j}+Q_j^*, \tag{17}$$

$$j=1, \ldots, n$$

d'un certain mouvement simple et que les équations (5) déterminent le mouvement troublé. La solution générale connue des équations simplifiées (17) sera représentée par un système des fonctions qui expriment les q_j et les p_j à l'aide de t et de $2n$ constantes arbitraires $c_1, \ldots, c_{2n}$. Suivant la voie bien connue on s'efforcera à satisfaire aux équations du mouvement troublé par les mêmes fonctions en y traitant toutefois les c_r comme des variables inconnues.

Posons $z_r=c_r$, écrivons C_r, C_r^* au lieu de Z_r, Z_r^* ($r=1, \ldots, 2n$) et, pour éviter toute confusion, employons pour un moment le signe ∂' pour désigner les dérivées des fonctions exprimées au moyen de $q_1, \ldots, q_n, p_1, \ldots, p_n, t$, en réservant le ∂ sans accent pour les dérivées des fonctions exprimées en $c_1, \ldots, c_{2n}, t$.

Le fait que les q_j et les p_j satisfont aux équations (17) se traduit par les relations

$$\frac{\partial q_j}{\partial t}=\frac{\partial' H^*}{\partial p_j}, \quad \frac{\partial p_j}{\partial t}=-\frac{\partial' H^*}{\partial q_j}+Q_j^*,$$

$$j=1, \ldots, n$$

et il s'ensuit que

$$\frac{\partial H^*}{\partial c_r}=\sum_j\left(\frac{\partial' H^*}{\partial q_j}\frac{\partial q_j}{\partial c_r}+\frac{\partial' H^*}{\partial p_j}\frac{\partial p_j}{\partial c_r}\right)=$$

$$=\sum_j\left(-\frac{\partial q_j}{\partial c_r}\frac{\partial p_j}{\partial t}+\frac{\partial q_j}{\partial t}\frac{\partial p_j}{\partial c_r}+Q_j^*\frac{\partial q_j}{\partial c_r}\right)$$

En comparant les expressions de δA^* en δq_j et en δc_r on remarquera que

$$C_r^*=\sum_j Q_j^*\frac{\partial q_j}{\partial c_r}$$

à l'aide de cette relation la formule précédente prend la forme

$$\frac{\partial H^*}{\partial c_r}+[c_r, t]=C_r^* \tag{18}$$

En faisant

$$\Delta H=H-H^*, \quad \Delta C_r=C_r-C_r^*, \tag{19}$$

$$r=1, \ldots, 2n$$

et tenant compte de (18), les équations (15) prennent la forme

$$\frac{\partial(\Delta H)}{\partial c_r}+\sum_s [c_r, c_s]\frac{dc_s}{dt}=\Delta C_r, \tag{20}$$

$$r=1, \ldots, 2n$$

Dans le cas particulier où les équations simplifiées (17) représentent un système conservatif ($Q_1^* = \ldots = Q_n^* = 0$) on a, d'après le théorème de Lagrange, cet avantage que les crochets $[c_r, c_s]$ ne contiennent pas le temps explicitement.

On observera que cette conclusion est tirée sans rien supposer du système troublé (5).

Supposons enfin que les c_r sont des constantes canoniques, leur ensemble se partageant en deux séries $a_1, \ldots, a_n$ et $\theta_1, \ldots, \theta_n$. En s'aidant des relations connues

$$[a_j, a_k] = [\theta_j, \theta_k] = 0, \quad [a_j, \theta_k] = -[\theta_k, a_j] = \begin{cases} 1 \text{ pour } j = k \\ 0 \text{ pour } j \neq k \end{cases}$$

on obtient alors les équations (10) sous la forme

$$\frac{da_j}{dt} = \frac{\partial(\Delta H)}{\partial \theta_j} - \Delta\theta_j, \qquad \frac{d\theta}{dt} = -\frac{\partial(\Delta H)}{\partial a_j} + \Delta A_j, \qquad (21)$$

$$j = 1, \ldots, n$$

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CHEMISTRY

A NEW SERIES OF IRIDIUM SULPHITO-CHLORIDES

By M. M. GURIN

(Communicated by I. I. Černjaiev, Member of the Academy, 5. I. 1944)

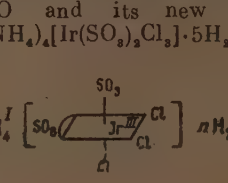
In the inner sphere of complex compounds of tervalent iridium the presence of various addends located according to the law of octahedral symmetry has been established by experiment. In case the chlorine atom, or the sulphito-group are the addends, the following transition series of acido-complexes can be deduced theoretically in agreement with Werner's octahedral scheme:

$M_3^I[Ir^{III}Cl_6]$	(1)	$M_4[Ir(SO_3)Cl_5]$	(2)	$M_3[Ir(SO_3)Cl_4]$	(3)
$M_5[Ir(SO_3)_2Cl_4]$	(4)	$M_4[Ir(SO_3)_2Cl_3]$	(5)	$M_3[Ir(SO_3)_2Cl_2]$	(6)
$M_6[Ir(SO_3)_3Cl_3]$	(7)	$M_5[Ir(SO_3)_3Cl_2]$	(8)	$M_4[Ir(SO_3)_3Cl]$	(9)
$M_3[Ir(SO_3)_3]$	(10)	$M_7[Ir(SO_3)_4Cl_2]$	(11)	$M_6[Ir(SO_3)_4Cl]$	(12)
$M_5[Ir(SO_3)_4]$	(13)	$M_8[Ir(SO_3)_5Cl]$	(14).	$M_7[Ir(SO_3)_5]$	(15)
		$M_9[Ir(SO_3)_6]$	(16)		

Evidently, all of these compounds are not equally stable or accessible synthetically. In fact, the ways for the synthesis of many of the compounds given above are not clear at all, because we have no sufficient knowledge of chemical transformations taking place in iridium complexes. Up to the present only the representatives of 9 types of compounds out of 16 in the above series have been known. Compounds of the types (1), (2), (3), (5) and (15) have been described by Claus ([1], [2]); those of the types (13) and (15) by Seubert ([3]); type (10) by Birnbaum([4]), and the description of types (4), (5) and (11) has been given by Lebedinsky and Gurin ([5]).

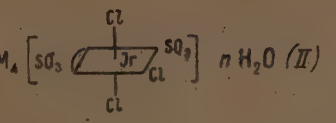
The diversified nature of the «deduced» types of complex compounds can be explained by the variable coordination «capacity» of the sulphito-group, and possibly by the presence within the same molecule of sulphito-groups having different «capacities». If the latter suggestion is accepted, the structure of compounds of types (5), (6), (8), (9), (12), (13) and (15) with quasi-coordination numbers 4, 5 and 7 can be easily interpreted within Werner's octahedron.

The peculiar structure of complex compounds of type (5) is of particular interest. On the strength of some data obtained by Lebedinsky and Gurin ([5]) the following coordination and geometrical structure should be assigned to the salt of Claus $K_4[Ir(SO_3)_2Cl_3]\cdot 6H_2O$ and its new analogues obtained recently $(NH_4)_4[Ir(SO_3)_2Cl_3]\cdot 3H_2O$, $(NH_4)_4[Ir(SO_3)_2Cl_3]\cdot 5H_2O$ and $NaRb_3[Ir(SO_3)_2Cl_3]\cdot 6H_2O$



$$M_4^I\left[SO_3\!\!\left(\begin{matrix}SO_3\\ Ir^{III}\\ Cl\end{matrix}\right)Cl\right]\cdot nH_2O,\ (I)$$

The position of the addends in these salts according to the type of the isomeric salt

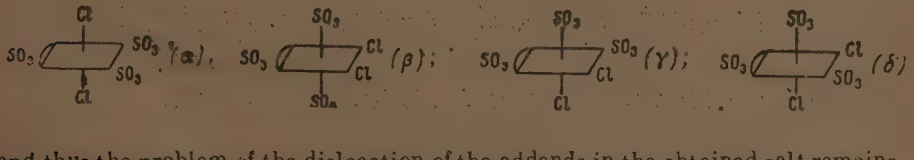


or the use of the formula of the aqua-salt

$$M_4[Ir(SO_3)_2Cl_3H_2O](n-1)H_2O \qquad (III)$$

(n being 3, 5 and 6 in various salts) seems to us less probable. Nevertheless, the problem connected with the structure of the complexes of the type of Claus' salt cannot be considered up to now as solved. For this reason it seemed extremely important to obtain additional support of the correctness of the opinions expressed by the authors. One of such supports might be the synthesis of new complex compounds, up to now unknown, but theoretically predicted and resembling by their character the salts of type $M^I_4[Ir(SO_3)_2Cl_3]$(5). The substitution of one chlorine atom in salts of this type by a sulphito-group should give complexes $M_5[Ir(SO_3)_2Cl_2]$ (8).

We have been able lately to prepare several complexes belonging to this new series. Under the action of a considerable excess of NH_4HSO_3 upon ammonium chloroiridite crystals of the ammonium salt $(NH_4)_5[Ir(SO_3)_3Cl_2]$ have been isolated. This salt does not crystallize as a hydrate, which is a very important circumstance for elucidating the structure of complexes belonging to types (5) and (8). Thus, the structures of type (III) with a water molecule in the inner sphere are excluded. Nevertheless, in our case four isomeric forms are possible, having the following configurations of the inner sphere:



and thus the problem of the dislocation of the addends in the obtained salt remains unsolved. Let us only note that the anion $[Ir(SO_3)_2Cl_2]'''''$ is very stable—the ammonium salt can be recrystallized and under the action of KOH or NaOH the potassium or the sodium salt can be obtained: $K_5[Ir(SO_3)_2Cl_2]\cdot 5H_2O$ and $Na_5[Ir(SO_3)_2Cl_2]\cdot 6H_2O$. These salts are rather poorly soluble in water and separate as a penta- and hexahydrate, correspondingly. The initial ammonium salt can also be prepared as a dihydrate. Below conditions are described for the synthesis of all these compounds.

1. Ammonium trisulphito-dichloroiridiate $(NH_4)_5\cdot[Ir(SO_3)_3Cl_2]$. The initial solution of NH_4HSO_3 was prepared as follows 20 g of $(NH_4)_2CO_3$ were dissolved in 120 cm³ of water, and the solution was saturated with SO_2 until the reaction was acid; 1 g of $(NH_4)_3IrCl_6\cdot 4H_2O$ was added to this solution of NH_4HSO_3. After the dissolution of the salt (under heating) the colour of the solution changed rapidly passing from olive-green through dark-red to light-yellow. When the solution became almost colourless, a new portion (15 cm³) of a freshly prepared NH_4HSO_3 solution was added. After the solution was cooled, there separated large light yellow crystals, having the form of rhombohedra.

The analysis of the salt gave the following results:

Weight portion 0.1050 g gave 0.0344 g Ir and 0.1296 g $BaSO_4$
» » 0.1006 g » 0.0324 g Ir » 0.1252 g $BaSO_4$
» » 0.1022 g » 0.0498 g AgCl

For $(NH_4)_5[Ir(SO_3)_3Cl_2]$

		Ir	S	Cl
Calculated %		32.49	16.19	11.93
Found %	I	32.76	16.94	12.05
	II	32.21	17.08	—

Crystallization of the ammonium salt was carried out under the following conditions: a weight portion of 1.6 g $(NH_4)_5[Ir(SO_3)_3Cl_2]$ was dissolved in 10 cm^3 of water under heating. Then a portion (5 cm^3) of ethyl alcohol was added. After cooling the amount of crystals that separated was 1 g. According to analysis, the recrystallized salt contained 32.75 per cent Ir and 16.32 per cent S.

A weight portion of the salt (0.1 g) was placed in a vacuum-desiccator (over H_2SO_4) and left there for a week at 20° C. No change in weight was observed. When a weight portion of the salt 0.0988 g was heated in a thermostat at 60°, no change was observed; at 80° the loss in weight was 0.0008 g (0.8 per cent); at 100°, 0.0014 g or 1.4 per cent; at 120°, 0.0024 g; at 170°, 0.0378 g or 38 per cent. At temperatures above 100° the salt decomposed, ammonium sulphite volatilized. In that respect the salt behaved like the ammonium analogue of Claus' salt $(NH_4)_4[Ir(SO_3)_2Cl_2]$.

2. Ammonium trisulphito-dichloroiridiate. Dihydrate $(NH_4)_5[Ir(SO_3)_3Cl_2]\cdot 2H_2O$. Conditions for the preparation of the hydrated salt coincided with those for the preparation of the anhydrous salt, with the only exception that after the intrusion process was at an end (the solution is light yellow, almost colourless), no fresh portion of NH_4HSO_3 was added. After cooling rhombohedral crystals separated. Their analysis gave the following results:

Weight portion 0.1016 g gave 0.0310 g Ir and 0.1152 g $BaSO_4$
» » 0.1046 g » 0.0322 g Ir
» » 0.1416 g » 0.1572 g $BaSO_4$
» » 0.1034 g » 0.0485 g AgCl

For $(NH_4)_5[Ir(SO_3)_3Cl_2]\cdot 2H_2O$

		Ir	Cl	S
Calculated %		30.63	11.25	15.24
Found %	I	30.51	11.60	15.56
	II	30.78	—	15.24

It should be noted that the action of neutral ammonium sulphite $(NH_4)_2SO_3$ upon ammonium chloroiridiate also led to the separation of the dihydrate which, however, was not so pure and needed reprecipitation (analysis: Ir, 30.82 per cent, 31.34 per cent; S, 15.61 per cent; Cl, 12.25 per cent, 12.34 per cent).

3. Potassium trisulphito-dichloroiridiate. Pentahydrate $K_5[Ir(SO_3)_3Cl_2]\cdot 5H_2O$. 1.5 g $(NH_4)_5[Ir(SO_3)_3Cl_2]$ and 4.5 g KCl were dissolved in 30 cm^3 of water and then 2 cm^3 of a 50 per cent KOH solution were added. Immediately there separated yellow crystals of the potassium salt. Under the microscope the crystals were very thin plates of a square form. The potassium salt is much less soluble in water than the ammonium one.

Weight portion 0.1050 g gave 0.0259 g Ir
» » 0.1742 g » 0.0423 g Ir and 0.0612 g AgCl
» » 0.1014 g » 0.0870 g $BaSO_4$
» » 0.1002 g » 0.0910 g $BaSO_4$
» » 0.2586 g » 0.1384 g K_2SO_4
» » 0.2657 g lost at 100° 0.0290 g H_2O
» 0.1174 g lost at 2° 0in a desiccator over sulphuric acid 0.0124 g H_2O

For $K_3[Ir(SO_3)_3Cl_2]\cdot 5H_2O$

		Ir	S	Cl	K	H_2O
Calculated %		24.45	12.18	8.98	24.75	11.40
Found %	I	24.66	11.78	8.68	24.01	10.91
	II	24.28	12.46	—	—	10.56

4. Sodium trisulphito-dichloroiridiate. Hexahydrate $Na_5[Ir(SO_3)_3Cl_2]\cdot 6H_2O$. 1.5 g $(NH_4)_5[Ir(SO_3)_3Cl_2]$ were dissolved in 30 cm³ of water. The solution was slightly heated and then 3.5 g NaCl + 3 g NaOH were added. On heating there separated a pale yellow precipitate of an indefinite crystalline form. The precipitate was poorly soluble in water. Analysis gave the following results:

Weight portion 0.1004 g gave 0.0274 g Ir and 0.0954 g $BaSO_4$
» » 0.1030 g » 0.0278 g Ir » 0.1008 g $BaSO_4$
» » 0.1004 g » 0.0396 g AgCl
» » 0.2511 g lost at 100° 0.0373 g H_2O
» » 0.1000 g gave 0.0470 g Na_2SO_4

For $Na_5[Ir(SO_3)_3Cl_2]\cdot 6H_2O$

		Ir	S	Cl	Na	H_2O
Calculated %		26.55	13.22	9.75	15.81	14.86
Found %	I	27.29	13.04	9.76	15.21	14.85
	II	26.99	13.43	—	—	—

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CHEMICAL TECHNOLOGY

A CYCLIC PROCESS OF ALUMOTHERMAL PRODUCTION OF CARBON-FREE FERRO-ALLOYS

By I. I. KORNILOV

(Communicated by I. I. Černjaiev, Member of the Academy, 14.X.1943)

One of the ways in which pure metals (chromium and manganese) and ferro-alloys very low in carbon can be produced is by using the alumothermal method. It is also essential while employing it that the ingredients involved contain no carbon and the reduction reaction be carried out outside the electric arc furnace.

At present this method is used for the production of metallic chromium (1), manganese (1), ferro-titanium (2), a chrome-aluminium intermediate alloy (3) and ferro-chrome aluminium (4).

Chrome-aluminium and ferro-chrome aluminium are used as intermediate alloys in manufacturing heat-resistant, low-carbon ferro-chrome aluminium alloys Nos. 1 and 2 (5).

Of late the present author has developed an alumo-thermal method for obtaining low-carbon ferro-chrome (4) from a low-silicon concentrate of chromium ore (6).

However, the use of alumothermal method in obtaining carbon-free pure metals and ferro-alloys is limited by the high cost and shortage of aluminium. As an outgrowth of his work on the production of low-carbon ferro-chrome and an intermediate alloy of ferro-chrome aluminium, the present author has proposed the so-called cyclic process of alumothermal production of low-carbon ferro-alloys.

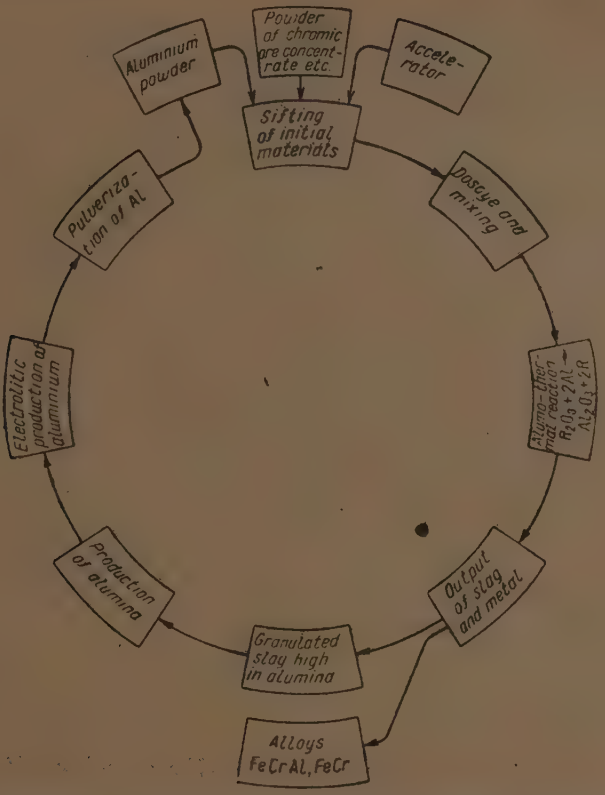
The idea of this process consists essentially in the following. A low-silicon concentrate of chromium ore (6) is subjected to reduction by aluminium in the presence of accelerators (4). In the process of alumothermal reduction there is obtained a carbon-low ferro-alloy of the requisite composition and a slag high in alumina. The compositions of the ferro-alloys have been given in an earlier paper (4), and the composition of the slag is given in Table 1. The alumina slag, which contains calcium oxide, is subjected to a treatment whose aim it is to obtain from it aluminium.

Afterwards this aluminium is carried back in the process of production of low-carbon ferro-alloys.

The manufacture of ferro-chrome and ferro-chrome aluminium alloys destitute of carbon, can be organized in such a way that no aluminium is expended outside the process.

The possible technical losses of aluminium in the process of slag treatment described and during the melting of the ferro-alloy are offset by the presence of 8—10 per cent of alumina in the concentrate of chromium ore. In course of the alumothermal process all of this alumina passes into the slag.

The cyclic process suggested here can be carried out according to the scheme represented in the adjoined figure.



Cyclic process of alumothermal production of carbon-free ferro-alloys

Table 1

Compositon of Slags in % by Weight

Al_2O_3	Cr_2O_3	SiO_2	MgO	FeO	CaO
			Slags of two-component intermediate alloy		
85.36	1.41	0.46	0.48	0.54	8.50
90.98	1.10	0.16	0.46	0.21	5.70
88.68	0.53	0.46	0.51	0.25	7.00
			Slags of ferro-chrome		
44.70	7.43	0.12	13.50	3.88	29.03
58.00	7.16	0.52	13.12	2.88	23.50
50.75	8.25	1.24	12.24	2.70	28.08
			Slags of three-component intermediate alloy, ferro-chrome aluminium		
51.62	3.15	0.25	—	2.70	27.6
63.20	4.0	0.40	11.42	0.71	21.40
54.61	6.25	1.20	12.60	—	21.29

In the main the cyclic process involves three chemical operations:

1) reaction of oxides reduction by aluminium

$$R_2O_3 + 2Al \rightarrow Al_2O_3 + 2R$$

2) chemical transformation of alumina slag according to the scheme

$$CaO \cdot Al_2O_3 + Na_2CO_3 \rightarrow 2NaAlO_2 + CaCO_3$$

3) electrochemical production of aluminium

$$Al_2O_3 + \text{electric energy} \rightarrow 2A + 1.5O_2$$

The composition of alumina slags can be varied according to the conditions under which the transformation of these slags into alumina is carried out.

This transformation of alumina slag clearly entails no necessity of designing new methods for the production of alumina.

The optimal conditions for the separation of pure alumina from slags can be inferred from the technological processes adopted in alumina plants. There are three methods which seem to suit their purpose equally well: a) the transformation of the slags with alkali under pressure according to Meyer's method; b) the caking of the slags with sodium carbonate at high temperature followed by leaching out of sodium aluminate; c) the alumothermal production of slags corresponding in composition to two calcium aluminates ($CaO \cdot Al_2O_3$ and $5CaO \cdot 3Al_2O_3$) with their subsequent leaching with sodium carbonate without sintering.

Decisions in choosing between these methods should be based upon the technical and economical indices of the process by which the slags are converted into alumina. Analyses of the available experimental data on the technology of ferro-alloys production speak in favour of the third of the above-mentioned methods. The slags obtained in that way (Table 1) have a low melting temperature and are easily crumbled and leached. They contain no more than 1.5 per cent silica, 4 per cent iron oxide and 6 to 8 per cent chromium oxide.

Preliminary experiments have shown that in the presence of slight admixtures of silica and iron oxide the process follows a simpler scheme. Also the expenditure of alkali in leaching is reduced in this case, and the alumina obtained is of a high quality.

Nor has chromium oxide any detrimental influence on the process of leaching-out of alumina when the latter is obtained from calcium aluminates mixed with a sodium carbonate solution.

In Table 2 are given some data on the leaching of the alumina slags corresponding in composition to calcium aluminates. As may be seen from this table, the alumina thus obtained contains hundredths of a per cent of silica, only 0.13 to 0.22 per cent of alkali and no chromium oxide at all. The yield of alumina is 85 to 90 per cent under laboratory conditions.

Table 2

Leaching of Slags

Composition of slag in % (by weight)					Composition of alumina obtained from it (in %)			
Al_2O_3	CaO	Cr_2O_3	SiO_2	MgO	SiO_2	Fe_2O_3	NO_3a	Al_2O_3 from the difference
37.4	45.6	4.5	0.3	12.6	0.05	0.10	0.13	99.72
41.6	50.9	6.8	0.2	0.5	0.08	0.06	0.27	99.69
54.5	26.5	6.1	0.35	12.15	0.10	0.07	0.19	99.64
65.2	32.17	1.56	0.41	0.48	0.06	0.08	0.21	99.65
52.7	25.2	8.5	1.2	12.6	0.12	0.09	0.22	99.57

The principal advantages with the cyclic process of alumothermal production of concentrate of chromium ore are as follows:

1) The ferro-chrome and the intermediate alloy of ferro-chrome-aluminium thus obtained are of high quality and very low in carbon.

2) A higher proportion of chromium is extracted from the concentrate (80—85 per cent), as compared to that obtained by the electro-metallurgical process.

3) The slags obtained can be converted into aluminium according to a simpler scheme and at a lower cost.

4) The expenditure of electric energy per one ton of metallic chromium in producing carbon-free ferro-alloys is lower by as much as 20—25 per cent, if the amount expended on the production of aluminium is taken into account.

5) The range of applicability of this method covers the production of metallic chromium from chromium oxide, manganese, ferro-titanium and other processes of alumothermal production of pure metals and ferro-alloys.

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GEOLOGY

ON RYANITE IN SEDIMENTARY ROCKS OF THE EUROPEAN USSR

By V. P. BATURIN

(Communicated by W. A. Obruchev, Member of the Academy, 29. X. 1943)

As early as 15 years ago the author published a short article dealing with ryanite in the sands of the productive series of the Apsheron peninsula (1). It was then the first mention about ryanite in the mineral beds of this Union.

The discovery of ryanite and other metamorphic minerals in the sands of productive series and still earlier in the recent deposits in the South of the Russian platform (P. N. Chirvinsky) enabled the author to entirely reconstruct the Caspian palaeogeography on the basis of petrographic analysis (2).

From a single finding of ryanite and conclusions concerning the Caspian Sea only, the author proceeded to the history of the above mineral in the deposits of the whole European part of the USSR. Being very schematic and fragmentary, this history reveals, however, a number of regularities which are of interest to those who deal with the geology of the extensive Russian platform and the surrounding folding system.

The conclusions drawn at the very first stage of the work from general photographic and geotectonic considerations and from the available data on the mineralogy of the Quarternary sands of the Volga and Pechora basin, gave us ground to assert that the Baltic shield was the main source of metamorphic minerals.

Some data now at hand show that the mother rocks of metamorphic rocks might occur not only in the northern, but also in some other parts of the platform, as well as in the adjoining folding system.

It is to be noted, however, that the districts mentioned above played but a secondary rôle as distributive provinces of ryanite.

The study of ryanite in clastic sediments should be started from the Paltic shield which is the main distributive province, but since, as far as the author knows, there are no works analysing the above district from the viewpoint we are interested in, he immediately proceeded to the study of the belt of the most ancient sedimentary formation, bordering on the Baltic shield in the South.

The first occurrence of ryanite has been recorded by M. F. Filippova (3) in the Middle Devonian lagoon-continental Luzhsky sands, Leningrad district, immediately bordering on the northern continent. The Narva beds resting upon the Silurian, as well as the Obulus beds S_1(4) contain no ryanite. According to Filippova, the composition of pebble found in the Middle Devonian beds of the Leningrad district (granite, shokshin quartzite and others) testifies to the decomposition of rocks now occurring in Karelia and Finland.

We dispose of data from petrographical investigations by different authors (unpublished), from which it may be inferred that ryanite-bearing sediments washed from the Baltic shield in the Devonian age, did not reach the Moscow basin.

Further to the South ryanite occurs in Devonian sands of the Ukraine, immediately underlying the Carboniferous deposits and tapped by the well No. 8, Romny (5).

The low content of ryanite and, mainly, the general character of the mineral association differing from that of the Leningrad Devonian deposits points to the independent character of the ryanite distributive provinces in the Devonian deposits of the Ukraine. The Ukrainian crystalline belt in the southern part of the Ukraine might have been the distributive province.

The data on the mineralogy of the Lower Carboniferous terrigenous sediments are especially numerous. The Selizhar coal region is the most northern point for which data on the mineralogical composition of the deposits C_1 are available. According to Bazhanova ([6]), the ryanite content of the heavy residue reaches here 7 and averages 2.7 per cent.

Some informations on the mineralogy in the Moscow basin are to be found in the works of L. V. Pustovalov ([7]), L. M. Birina ([8]), M. S. Shvetzov, R. M. Pistrack and others. These authors have pointed out that the sands of the coal series contain rather large quantities of ryanite together with staurolite and occasionally sillimanite.

From the above said we may conclude as to the northern origin of ryanite and other metamorphic minerals in the sands of the Moscow basin. This conclusion is confirmed by Shvetzov's thorough investigations ([9]). According to this writer, an extensive delta with a river system drained Karelia and Finland during the coal cycle C_1.

In the eastern part of the Donetz basin situated far from the Ukrainian crystalline belt ryanite is almostentirely absent ([10], [11]), which indicates that terrigenous products were brought to this sedimentation zone from other, probably more southern parts of the continent, which do not exist at present.

The influence of the Baltic shield on the formation of Carboniferous sediments was gradually decreasing towards the eastern border of the Russian platform. In Syzran and Chistopol ([11a]) ryanite may occasionally be encountered, but farther to the East, as well as in the coal beds of the Kizelovsky region, it is altogether absent. Such a distribution of ryanite shows that the Baltic shield did not take part in the formation of terrigenous deposits of the Lower Carboniferous of the eastern part of the Russian platform and the Urals.

After a long period of carbonaceous sedimentation mountain systems were formed to the East and South of the Russian platform in the period between Palaeozoic and Mesozoic. Thick deposits of terrigenous sediments began to accumulate at the foot of the young Urals and the Donetz ridge. Thorough investigations of the mineralogical composition of the Permian and partly of the Triassic deposits were conducted along the western slope of the Urals. Similar but less thorough investigations were also carried on in the region of the Donetz basin. No ryanite was discovered in the above deposits (except rarely encountered single grains), the fact showing that the new mother rocks did not complicate the scheme of the arrangement of distributive provinces.

The data on the mineralogy of Mesozoic clastic rocks of the European part of the USSR are rather scarce. Pustovalov ([7]) has discovered ryanite in Callovian deposits where, according to this author, the mineral was carried in by the erosion of the Lower Carboniferous deposits. In the north-western part of the Donetz basin ryanite has first been discovered in the Jurassic ([12]).

The fundamental remodelling of the configuration of the epicontinental basin of the Russian platform, as pointed out by A. P. Karpinsky, took place at the boundary of the Upper and Lower Cretaceous.

Since this period the northern part of the platform began to transform into land, while the southern one became a marine shallow basin.

Simultaneously with this transformation the river system underwent radical changes too, forming a number of arteries running from the North southwards. These undoubtedly abundant river systems heading from the Baltic shield and draining farther to the South its derivatives (Palaeozoic formations) carried along large masses of quartz sediments containing ryanite and staurolite. The Cretaceous deposits of such composition have been described by Malyshek ([13]) for Kamyshin (near the Volga).

In the Palaeogene deposits the ryanite-staurolite association occurs all over the vast territory of the Ukraine. From the Dnieper to the Don ryanite, staurolite and occasionally sillimanite are the chief components of the heavy residue of Tertiary sands. Ryanite also occurs in small quantity in the Maikop series of the northern slope of the Caucasus mountain range ([14], [15]).

In the Maikop deposits of the Transcaucasia and the eastern termination of the Main Caucasus range ryanite has rarely been discovered, if at all ([17]). Judging from personal observations ([2]) and scarce published data ([18]) it is also absent from the Palaeozoic and Mesozoic rocks of the same regions.

While in the Maikop age (when at the Caucasus the sedimentation of pelitic sediments was in progress) ryanite was comparatively infrequent and occurred chiefly in the western part of the northern slope, in the Caucasus range in the Chockrak-Karagan beds (Middle Miocene) it was rather widely distributed. A band of quartz sands of the Chockrak-Karagan beds stretches from the Kertch strait through Daghestan to Kabristan (Azerbaidjan). The beds contain ryanite, staurotite and sillimanite, their content noticeably decreasing southwards ([16]). The ryanite of the Chockrak-Karagan marine basin was also brought here from the region of the western Caucasus, as well as from the northern dry land (the Russian platform). It is to be noted that the configuration of terrigenous-mineralogical provinces and the area of sandy sediments of the second Mediterranean horizon show that the main northern artery carrying clastic material was somewhere in the lower part of the land along the Volga. If we recall the finding of the ryanite-staurolite association in the Cretaceous deposits of Kamyshin and connect this with the fact just referred to, we easily understand that since the Mesozoic epoch the Volga belt was an alluvial tract stretching from crystalline shales and granite-gneiss of the Baltic shield to the southern Russian basins of the Tethis sea.

At the Caucasus during the post-Karagan age the continuously increasing erosion and the transportation of the Caucasian clastic products soon suppressed the influence of the northern sources of terrigenous sediments and resulted in the formation of quite different new associations (epidote, hornblende and pyroxene) in the Caucasian Miocene and Pliocene basins. Only in the age of productive series (Middle Pliocene) in connexion with the fundamental reconstruction of the continent in the Caspian region, sands containing ryanite and staurolite were transported by the Palaeovolga to the latitude of the Apsheron peninsula ([2]).

As it follows from the title of his article, the author did not aim at giving here a complete work on clastic ryanite. His purpose was to show that its migration embracing almost all the post-Proterozoic history of a considerable part of Eurasia, is a most interesting palaeogeographic document we are beginning to understand.

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GEOLOGY

HUMIC-SAPROPELIC COALS OF THE DONETZ BASIN

By F. A. BOCHKOVSKY

(Communicated by N. P. Chizhevsky, Member of the Academy, 26. VI. 1943)

The presence of sapropelic coals in the Donetz basin has long since been recorded by B. F. Meffert (1). However, he declared them to be but poorly developed there. And this opinion has become so deeply rooted that even in recent and more detailed investigations, the sapropelic coals of the Donetz basin are being ascribed a merely mineralogical significance (2).

This opinion found also support in the view prevailing among geologists, *viz.* that coals of the sapropelic type and of a type intermediate between the sapropelic and the humic one, are confined to fresh-water lacustrine facies only, and cannot be extensively developed in the Donetz basin where the accumulation of coals had taken place in the coastal sea zone. Neither did this type of coal attach interest of coal engineers; because of their high ash content, if a seam of humic coal was found to show a considerable development of sapropelic coal, the working of the former was suspended (seam m_1 in the Grigorjevsky shaft No. 12/13 bis, *etc.*). And yet, our investigations have shown that coals of the sapropelic type are widely distributed over the Donetz basin, and can be used for industrial purposes. The first who paid attention to this fact was B. S. Chernyshev, Member of the Academy; in giving a characteristic of the *Carbonicula* and *Anthracomya* facies, he pointed out that among the rocks confined to these facies carbonaceous shales are developed to a considerable extent and may be of practical importance because of the paraffin present in them. Many of these carbonaceous shales, according to the author's investigations, are humic-sapropelic coals or carbonaceous argillites of the same type.

By a study of the facies in which the accumulation of coals took place, as well as a study of the enclosing rocks, the author has been led to a number of conclusions which are in conflict with the view held at present as to the influence of carbonization upon sapropelic coals, the development of coals of this type in the Donetz basin, and their practical utilization.

The coals of the sapropelic type in the Donetz basin consist of five principal components: algae, spores, humic matter, mineral admixtures and sapropelic groundmass.

The part played by each of these components varies within a wide range, but since humic matter is invariably present in a considerable amount, these coals are given the name of humic-sapropelic. As distinguished from the classification of Stadnikov, the author applies the name of «humic-sapropelic coals» to that group of coals in which the sapropelic material may be distinguished under the microscope.

Contrary to the firmly established view that sapropelic coals are being accumulated in large amounts in continental lakes, the author's palaeogeographic inves-

tigations have shown that in parallic basins, too, no less favourable conditions for the accumulation of coals of this type are available.

These statements are confirmed by a number of examples: in the Grishino coal region, in one of the mining fields seam m_3 is now half- and now wholly composed of humic-sapropelic coal, the reserves of which, as revealed by prospecting, exceed 4 million tons; in the Lisichansk region in some of the shafts seam l_7 is wholly, and seam l_4 partly composed of this type of coal. In a number of other operating shafts humic-sapropelic coals have also been discovered. In spite of the fragmentary nature of the information available on humic-sapropelic coals, work carried on during 1940 alone is sufficient to augment these examples.

At present the view predominates that sapropelic coals very rapidly lose the features which distinguish them from humic coals, according as the degree of carbonization increases; beginning with the stage of gas coals, they are not sharply distinguishable from the surrounding humic coal, and in the coals of higher stages of carbonization they are altogether undistinguishable from them (3).

Investigations of humic-sapropelic coals have brought the author to the conclusion that the generally accepted view as to the influence of the increase of carbonization upon sapropelites is quite erroneous: humic-sapropelic coals occur in the Donetz basin among coals with the most different degrees of carbonization, from long-flame coals to anthracites, inclusively. In outward appearance, these coals are distinguished no less sharply from those with a low carbonization. From the chemical standpoint, the difference between the humic-sapropelic and the humic coals becomes still more sharply pronounced with an increase of the degree of carbonization: the ratio of the content of volatiles per the combustible mass in humic sapropelic coals (V_s^c) to the content of volatiles per the combustible mass in humic coals (V_h^c) for the long-flame coal group is 1.3. This ratio increases along with the degree of carbonization. Thus, for the gas coal seam m_3 in the Kurakhov area of the Grishino region $V_s^c/V_h^c = 1.62$, for the humic-sapropelic seam l_6 from shaft No. 1/1 bis at Tscherbinovka, where coals of the ПЭЖ mark are developed, $V_s^c/V_h^c = \frac{58.85}{34.99} = 1.68$. The humic-sapropelic coal belonging to the ПС mark, encountered in the «Budenovugol» shafts in seam h_{10}, contains 42.64 per cent of volatiles per the combustible mass, and thus for the coals of the ПС mark we have $V_s^c/V_h^c = 2.78$. Finally, among anthracite coals, the humic-sapropelic seam g_3 has been discovered in the Chistiakov region, in the «Krasny Perekop» shaft, with a volatile content 15.98 per cent per the combustible mass; the same seam within a distance of 1.5—2 km along the strike in the «Obushek» shaft is represented by humic coal, for which $V_h^c = 5.01$ per cent. Thus, for coals with the highest degree of carbonization $V_s^c/V_h^c = \frac{15.98}{5.01} = 3.1$.

From these facts it follows that while the quantity of volatiles in the sapropelic type of coals decreases with carbonization, this takes place at a considerably slower rate than in humic coals. It may be accounted for only by the fact that in fatty organic substances the volatile components are bound much more solidly than in humic substances.

The above ratio of V_s^c/V_h^c depends not only upon the degree of carbonization, but on the amount of fatty organic substances, too. In the above-mentioned seam h_{10} there are two intercalations of humic-sapropelic coal, one of them containing more humic matter than the other. The different composition is reflected also in the value of the V_s^c/V_h^c ratio. While for the intercalations with a lesser relative amount of humic matter it is 2.7, for the other intercalations it drops sharply and is equal to 1.37.

The data available at present on the distribution of humic sapropelic coals in the Donetz basin make quite timely the advancement of the problem as to the ways of using these coals.

According to their mode of occurrence, the humic-sapropelic coals of the Donetz basin can and should be worked by a complex method along with the accompanying thick humic complex seams, which could not be worked without the humic-sapropelic intercalations because of the insignificant thickness of the humic intercalations.

In addition, use will be made of the humic-sapropelic coals which are usually left in the ground or dumped.

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MINERALOGY

DANALITE IN THE PEGMATITES OF THE IMALKA DEPOSIT, EASTERN TRANSBAIKAL

By I. F. GRIGORIEV

(Communicated by A. E. Fersman, Member of the Academy, 24. X. 1943)

The Imalka tin-ore deposit, Eastern Transbaikal, presents outstanding interest from the petrological, geochemical and mineralogical standpoints. It was investigated by me in detail during 1937—38. This note in concerned solely with the mineral danalite which has never before been found in this country, and in the mineralogical literature no data on it are available.

The area of the Imalka deposit is composed of hornblendic biotite, quartz syenite-diorites. These rocks are cut by a whole series of scattered quartz-feldspar and pegmatite veins of the 1st generation, in the main from 340 to 360° along the strike, with a dip at angles of 20—45° and rarely 60° to the NE. The pegmatite and quartz-feldspar veins of the 1st generation in some places are in turn cut by pegmatite, pegmatite-aplite and aplite veins of the 2nd generation, striking: to the north-east (70—90°, with a dip 340—360° NW at angles of 15—35°) and to the north-west (320—350°, with a dip 50—80° NE at angles of 15—35°). Danalite occurs in pegmatite veins of the 2nd generation.

When examining this series of veins macroscopically, and especially under the microscope, it becomes quite evident that they have been formed mainly in two stages—the pegmatite and the pneumatolitic one. The hydrothermal and the subsequent hypergene stage are represented very poorly. In the pegmatite stage coarse-grained albite-oligoclase, microcline, quartz were formed, to which tourmaline, beryl, zircon and apatite were added in a subordinate amount. The pegmatite shows coarse-grained, spotted, porphyry-like and less frequently banded textures. Later on, these textures were complicated by a superposition of minerals of the pneumatolitic stage, during which albite, danalite, garnet, cassiterite, pyrite and muscovite were formed, replacing and corroding the minerals of the pegmatite stage. Prior to the pneumatolitic stage a crushing of the minerals of the pegmatite stage took place. In the hydrothermal stage actinolite, rutile, ilmenite, sphene, clinozoisite, zoisite, chlorite, sericite were formed in insignificant amounts; and in the hypergene stage, chalcedony and limonite.

Danalite in the pegmatite veins occurs frequently. The quantitative estimation of this mineral under the microscope and in specimens gives values from 0.05 to 0.1 per cent. Almost in every specimen at least one crystal of danalite may be discovered. On the surface it is generally decomposed and has a brownish-black colour. In the fresh fracture it is red-brown. The mineral belongs to the cubic syngony. It was formed either in octahedral crystals up to 1 cm in size, or as fine-grained aggregates attaining a size of 3×3 cm. Lustre from vitreous to greasy. Hardness 5.5. Specific gravity ranging from 3.32—3.33 to 3.44. Streak: chocolate. Refractive index ranging from 1.752 ± 0.002 to 1.759 ± 0.002. In thin-section danalite is iso-

tropic and brown-coloured. It is fringed with an aggregate of biotite, muscovite and albite. It was formed in the pneumatolitic stage along with the minerals listed above.

A chemical analysis of danalite, made at the Geochemical Laboratory of the Moscow Geological-Prospecting Institute, as well as chemical analyses made later on by I. G. Chentzov at the Laboratory of the Institute of Geological Sciences of the Academy of Sciences of the USSR, yielded the following results (see table).

Oxides	After I.F. Grigoriev spec. 876*		After I.G. Chentzov			
			spec. 204		spec. 286	
	weight %	molec. amounts	weight %	molec. amounts	weight %	molec. amounts
SiO_2	32.18	0.5363	32.83	0.5466	34.08	0.5674
TiO_2	traces	—	—	—	—	—
Al_2O_3	2.71	0.0266	—	—	—	—
Fe_2O_3	0.22	0.0014	—	—	—	—
FeO	34.23	0.4760	31.36	0.4365	30.56	0.4266
MnO	17.35	0.2450	14.55	0.2051	13.28	0.1872
ZnO	1.82	0.0224	3.91	0.0480	2.97	0.0364
CaO	0.07	—	—	—	—	—
MgO	0.32	0.0080	—	—	—	—
BeO	8.05	0.3207	14.46	0.5785	16.32	0.6522
K_2O, Na_2O	0.18	—	—	—	—	—
Loss on ignition at 105—10°C	0.08	—	—	—	—	—
S	5.25	—	5.62	0.1750	5.61	0.1750
Total	102.46	—	102.75	—	102.92	—
Correction for S	0—2.63	—	0—2.80	—	0—2.80	—
Total	99.83	—	99.95	—	100.12	—
Sp. gravity	3.44	—	3.33	—	3.32	—
Refractive index	1.759± 0.002	—	1.753± 0.001	—	1.752± 0.002	—

* S.Khovansky, analyst.

Moreover, spectrum analysis has revealed: Sn, lines of medium brightness; Cu, weak lines; Pb and Ge, traces of lines. The following elements have not been disclosed by spectrum analysis: Ba, As, W, Ga, Cr, Bi, V, Ti, Ag, Zr, Te, P, Sb, Pt, Na, Ta, Au, In, Mo, Cd, Ni, K, Sr, Re, Tl.

Upon recalculation of the data of chemical analysis to the elementary formula, a ratio of $SiO_2 : RO : RS = 3 : 7 : 1$ is obtained, *i.e.* the formula $(Be, Fe, Zn, Mn)_7 \cdot Si_3O_{12} \cdot S$ which is given by E. Dana on the basis of the work of Brogger. The Al_2O_3 and Na_2O discovered in danalite by chemical analysis seem to refer to albite found in danalite in minute inclusions when examined under the microscope. From its chemical composition the danalite from the Imalka deposit approaches most closely the danalite from Cornwall. An inspection of the diagram shows that in danalite there is an isomorphous mutual replacement of Mn, Zn and Fe. While the Imalka danalite is low in zinc and high in manganese and iron, in the Colorado danalite there is a marked predominance of zinc, while manganese and iron are present in insignificant amounts. According to the change in the content of Zn, Mn and Fe, the specific gravity of the mineral varies, too. In danalite with a high content of zinc (Colorado) the specific gravity is reduced to 2.661, while in danalite with a low zinc content (Imalka) the respective value is as high as 3.4.

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PALAEONTOLOGY

ON THE STRUCTURE AND RESPIRATORY FUNCTION OF THE ANAL SAC OF THE CRINOIDS

By N. N. YAKOVLEV, Corresponding Member of the Academy

A respiratory function is attributed to the well-known slit-like pores in the anal sac of Palaeozoic crinoids—*Poteriocrinus*, *Coeliocrinus*, *Zeacrinus* and other related genera.

Until now, however, it has not been established how the respiratory function was carried out.

On a specimen of a *Poteriocrinus* (probably, a new *Cromyocrinus* belonging to the group of *C. ornatus*) from the Lower Carboniferous strata of the Talas Alatau I have discovered certain hitherto unobserved peculiarities of the inner surface of the anal sac which are connected with the pores and evidently with the respiratory function as well.

Pores are to be found on five out of the twelve longitudinal rows of plates of which the anal sac is composed. The plates with pores on both sides (see figure) are marked CC_1C on the left-hand side of the transverse section of the anal sac.* These three rows of plates together with two adjacent rows form four furrows (*f*) on the outer surface of the anal sac. Into these furrows the pores open, each pore being formed by the edges of two plates belonging to two adjacent rows. Each of the two outer rows of plates has pores on its inner side, *i. e.* the one nearest to the middle of the porous zone.

This zone is situated to the right of the anal interradius with which two longitudinal rows of plates marked *aa* are connected.

On the inner surface of the anal sac, corresponding to the zone of the five rows of plates with pores, there are three canals (CC_1C), evidently serving to admit the water entering through the pores from the outside. The middle canal denoted by C_1 differs from the other two in form, position and formation. It is V-shaped and lies

* The section was made at a point where the distance from the cup is equal to the height of the cup.

lengthwise along the middle of the central row of pored plates, so that the transverse section of the plates reminds one of a section of an arm with an ambulacral furrow.

The two outer canals denoted by C differ from C_1 in form and origin, being formed by the edges of three pored plates, one of these forming the bottom of the canal and the other two, its sides.

It seems probable that these three canals contained three water carrying vessels running along the anal sec and continuing on the opposite side of the sac. This last supposition is based on the fact that the opposite side has also a corresponding set of three canals. Since on this side there are no pores on the plates, it is to be assumed that the water entering by the pores on the one side of the sac flowed through the canals towards the distal end of the sac, where the current turned back towards the mouth. It seems probable that the furrow of the central canal C_1 in the wall of the sac contained underneath the water-carrying vessel other organs—a neural cord and a blood-vessel, in the way as observed in the arms. In the side furrows C these other organs, if not altogether absent, may have been less developed, which may be suggested to account for the difference between them and the central furrow C_1.

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BOTANY

SOME STRUCTURAL DETAILS OF DIATOM *PLEUROSIGMA ELONGATUM* AS REVEALED WITH THE AID OF ELECTRON MICROSCOPE

By V. N. WERZNER

(Communicated by A. A. Lebedev, Member of the Academy, 14. I. 1944)

In the process of trying the electron microscope constructed at the State Optical Institute in 1941—1942, there was taken a large number of photographs of various diatoms which served as test-objects.

These photographs point to some new details in the structure of diatoms, and in so far as the latter are universally used as objects for testing light microscopes, it appeared of interest to publish them. And this the more so, as these photographs may at the same time give some idea of the resolving power of the electron microscope constructed at this Institute.

The most numerous are the photographs taken with the diatom *Pleurosigma elongatum**; in the majority of cases they reveal a structure analogous to that com-

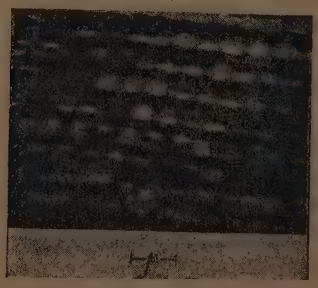

Fig. 1. Magnification 8000

Fig. 2. Magnification 16000

monly observable on photographs that had been obtained with the aid of an electron microscope by Ardenne (1), Prebus and Hillier (2) and Hamly and Watson (3) who were studying a different species of diatoms, *viz. Pleurosigma angulatum.*

The structure of the diatoms, as borne out by some of our photographs, is somewhat more complicated than that usually obtained. It rather reminds of the stereophotographs obtained by Ardenne (1), *viz.* instead of the elliptical pores commonly observed, there were seen apertures divided by a non-transparent partition parallel to the long axis of the ellipsis, which becomes especially apparent at certain positions of the valve (Figs. 1 and 2).

In Fig. 3 this partition of the pores into two parts is especially well-pronounced in the region of the valve axis, while the remaining pores had their usual appearance.

* The specimens of diatoms were obtained by Prof. B. V. Perfiliev.

When thoroughly examining Fig. 3 it may be seen that the first row of pores along the axis of the valve mostly displays an alternation of double and single elements.

Interpreting this picture Ardenne (1) believed some of the pores, *viz.* the elliptical ones, to be situated on the anterior surface, and the slit-like pores, on the posterior membrane of the diatom's valve. Hamly and Watson (3) assumed the existence of a thin, brittle membrane at a distance of 0.5 microns from the wall of the valve. Both these interpretations are at variance with the photographs obtained by the present author.

On these photographs (Figs. 1, 2 and 3) the outlines of the two apertures are equally distinct, and they seem therefore to be lying in the same plane. A defini-

Fig. 3. Magnification 11000.

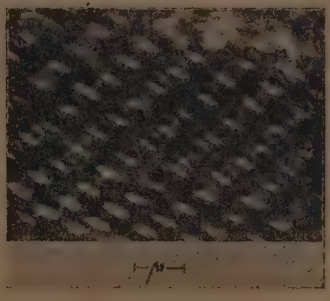

Fig. 4. Magnification 8000

tive solution of this problem will certainly require the application of stereophotography.

Of interest is also the photograph reproduced in Fig. 4; here, owing to a casual attitude of the valve, some new elements of the diatom's structure become observable.

It should be pointed out that visual observations of another diatom, *Geurosigma balticum*, characterized by a coarser structure, have also revealed the existence of a partition of the pores, which is especially conspicuous in the region of the axis of the valve.

State Optical Institute.

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14. I. 1944.

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ZOOLOGY

NEW FORMS OF INSECTIVOROUS MAMMALS

By S. U. STROGANOV

(Communicated by E. N. Pavlovsky, Member of the Academy, 8. I. 1944)

As a result of the treatment of material collected by the parasitological expeditions headed by Prof. E. N. Pavlovsky, Member of the Academy, and of other collections kept at the Zoological Institute of the Academy of Sciences of the USSR, the present author has established the following new forms of insectivorous mammals:

Hemiechinus homalacanthus sp. n. (*Erinaceidae*)

Diagnosis. Distinguished from the rest of long-eared hedgehogs by the smooth surface of its back spines, and by its glans penis lacking horny spines. There is but a single clear-cut dark pigmented subterminal annulation at the apex of each spine; the edge of the spine is light. Large sized: body length inclusive of head 225—237 mm (M 263), length of tail 47—49 mm (M 48), length of hind foot without claws 39—41 mm (M 40). Condylo-basal length of the skull 54.8—57.2 mm (M. 56.2), width of zygomatic arches 33.3—33.7 mm (M 33.5), length of upper set of teeth 25.3—27.1 mm (M 26.4). Length of spines up to 29.0 mm, thickness of spines 1.4—1.5 mm.

In the colouring of the back spines brown tinges are prevalent. The fur upon head and feet is browny-grey, with a considerable admixture of yellow-red hairs; upon the sides of the lower part of the neck and up the belly the fur is almost white.

Type. № 30 507, ♂ senex, 1934, coll. V. M. Antipin at Kabadiani, Tadjik SSR. Kept among the collections of the Zoological Institute of the Academy of Sciences of the USSR. Aside from the type, three specimens more have been examined.

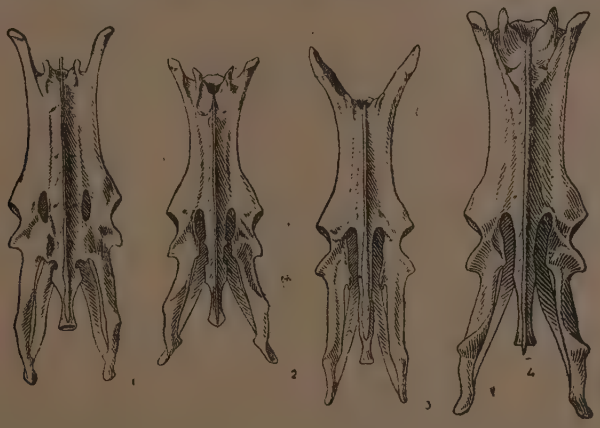
Geographical Distribution. Besides *terra typica*, the occurrence of this species has been reported for the following places: region of Jilikul and Aralsk valley of the river Vakhsh, where it has been obtained by B. S. Vinogradov, as well as the vicinity of the town Stalinabad, whence I received a specimen of this hedgehog in summer 1943.

Notes. *Hemiechinus homalacanthus* sp. n. represents one of the most primitive species of the genus *Hemiechinus*. The spines of this hedgehog bear on their surface neither tubercles with furrows between them, nor longitudinal crests which are so typical of the long-eared hedgehogs. As pointed out in the diagnosis, glans penis in the species under description is lacking the horny spines. In all the hedgehogs of the genus *Hemiechinus* known, upon the dorsal surface of glans penis there are two oval elongated crest-like horny tubercles arranged along the axis of the organ, parallel with respect to each other. In the hedgehogs of the genus *Erinaceus* tubercles of this kind form sharp spines on their apex and have therefore a serrate aspect when viewed sidewise.

The peculiarities pointed out above fully characterize the smooth-spined hedgehog as an independent species.

Talpa romana ognevi subsp. nov. (*Talpidae*)

Diagnosis. Large sized: body length inclusive of head 114—140 mm (M 134), tail length 27.0—29.3 mm (M 28.0), planta 19.0—20.0 mm (M 19.6). Total length of skull 35.6—37.7 mm (M 36.4), condylo-basal length 35.1—37.2 mm (M 35.9), maximum width 16.6—18.2 mm (M 17.1), width of the rhinal part above the canines 4.9—5.3 mm (M 5.1), space between foramina infraorbitalia 7.0—7.4 mm (M 7.2). Teeth very large; length of upper set of teeth 14.0—15.0 mm (M 14.5), which makes up about 40 per cent to the condylo-basal length of the skull; length of upper row of molars 7.0—7.3 mm (M 7.2); maximum diameter m^1, 3.7—4.3 mm (M 4.0). Middle pair of upper incisors considerably higher and



Structure of the pelvis: 1, *Talpa europaea* L.; 2, *Talpa caucasica* Satun.; 3, *Asioscalops altaica* Nik.; 4, *Talpa romana ognevi* subsp. n.

amlost twice as wide as the lateral ones. The posterior ridge of foramina infraorbitalia situated behind the mesostyle m^2. Proc. longus incudis twice as long as proc. brevis incudis; thickness of proc. longus in the middle is equal to that of proc. brevis at the base.

Type. No. 13239. Collections of the Zoological Institute of the Academy of Sciences of the USSR, ♂, 12.XI. 1914, at Bakuriani, Georgia. Aside from the type, two individuals from the same locality, and five from the vicinity of Kutaisi have been investigated.

Geographical Distribution. Found in the region of Bakuriani and in the vicinity of Kutaisi, at the Caucasus.

Notes. G. S. Miller ([2], [3]) recognized *Talpa romana* Thomas as an independent species on the basis of the large teeth peculiar to this mole. According to data secured by myself *T. romana* can easily be distinguished from the rest of European moles by the structure of its pelvis, as well: the latter is characterized by a lack of a bony connexion between the spinal column and the ishiadic bones. and by a peculiar shape of these bones. These peculiar features are clearly brought out in the figure adjoined.

Until recently the species here described has been reported from the vicinity of Rome (Italy) and from Yougoslavia only.

S. I. Ognev ([4]) had once investigated the type specimen of the subspecies under description, and found it very close to *Talpa romana*. It is on this occasion that he wrote: «It is a matter for regret that I studied but a single specimen of this interesting mole, and could therefore not make clear, whether I had to deal with

a new species, or with a rare deviation towards the increase of skull dimensions in *T. caucasica* Satun.». The collections of the Zoological Institute of the Academy of Sciences of the USSR were also found to contain two skulls from Bakuriani, and those of Georgian museum, five skulls from the vicinity of Kutaisi, quite similar as to their characters to those described by S. I. Ognev. I have thus examined a total of eight skulls of this mole, all of them belonging to adult individuals. This material is quite sufficient to form a conclusion that in this case we have to do with an independent taxonomic form rather than with a divergence from the type, the mole being characterized by very large teeth, by the position of foramina infraorbitalia and the structure of the auditory bones. The last character, as has previously been shown by the present author ([6]), is no less stable than the dental system, and is of high diagnostic value in the taxonomy of moles. In *T. r. ognevi* susbp. n. the proc. longus incudis is twice as long as proc. brevis incudis (in *T. caucasica* Satun. the length of proc. longus is 4 times, in *Asioscalops altaica* Nik. 5 times, and in *T. europaea* L. 6 times that of proc. brevis). The thickness of proc. longus is equal to that of proc. brevis at the base (in *T. caucasica* Satun. and *T. europaea* L. the thickness of proc. longus exceeds about 5 times that of proc. brevis measured at the base). The length of the upper set of teeth in *Talpa romana* makes up about 40 per cent of the condylo-basal length, while in *Talpa caucasica* Satun. it makes up about 38 per cent, in *T. europaea* L., about 37 per cent, and in *Asioscalops altaica* Nik. about 25 per cent. By its skull dimensions *T. r. ognevi* approaches most closely *T. r. romana* Thos., differing from the latter by its larger upper molars and by the structure of the mesostyle of these teeth. According to G. S. Miller ([2]), *T. romana* Thos. has a mesostyle with a double cusp, while in *T. r. ognevi* subsp. nov. the mesostyle has no such cusp. From *T. r. stankovici* V. et E. Martino the subspecies under description is distinguished by a larger skull; it has received from me its name in honour of Prof. S. I. Ognev.

Sorex mirabilis Ognev (*Soricidae*)

In 1937 S. I. Ognev ([5]) described a new species of *Sorex mirabilis* Ogn. That species of shrew has been known by a single specimen obtained in the Ussuri province, in the valley of the river Kishinka. A second specimen of this remarkable shrew, caught at the reserve «Kedrovaya pad» of the Maritime region, has been put at my disposal by A. V. Gvozdev, member of the anti-encephalitic expedition of 1940. The specimen investigated is larger that the type. Body length 90.9 mm, length of tail 71.9 mm, planta 17.1 mm. Condylo-basal length of skull 24.3 mm, maximum width 11.2 mm, height 6.1 mm, space between foramina infraorbitalia 4.2 mm, length of the upper set of teeth 9.7 mm.

Both dorsal and abdominal side show a uniform brown-black colour.

Zoological Institute.
Academy of Sciences of the USSR.

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8. 1. 1944.

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EVOLUTIONARY MORPHOLOGY

ON THE TWO TYPES OF REGRESS OF ORGANS IN THE ONTOGENESIS OF INSECTS

By D. M. FEDOTOV

(Communicated by I. I. Schmalhausen, Member of the Academy, 23. X. 1943)

Although it is well known that evolution is composed of both progressive and regressive processes, the latter are often given but little attention. However, the course of evolution cannot be understood without knowing the regularities underlying the regressive development. One of the most striking examples of regressive development is offered by the bag-worm moth (see Fedotov, 1939, 1940). In fact, the investigation of the structure and ontogenesis of *Pachytelia unicolor* Hufn. has revealed the ways of regress in ontogenesis, which are undoubtedly acting also as general regularities of the regressive evolution.

Male imagoes of this form are known to possess, on account of aphagia, strongly reduced mouth parts, while their intestine does not function at all as a digestive apparatus. The proctodeum alone was found to be functioning, and this, too, as a duct of the Malpighian tubes only. The mouth parts of the males are the rudiments of mandibles and maxillae and of the labium of the caterpillar, rather than a vestige of the proboscis and of parts of the labial and maxillary palpi of the moth, as previously supposed. The mouth parts of a male larva do not undergo transformation into imaginal organs, but, being reduced in the pupa, pass to the moth without metamorphosis. Thus, the maxillae of the larva, remaining wide apart, divided by the labium and preserving their position with respect to each other, as the rest of the mouth parts, become in the imago negligibly small vestiges.

In an imago female almost all the organs retain their larval character, showing, however, regressive features of some degree. The mouth parts, ocelli, thoracic legs, nervous system, body musculature, tracheal system, the dorsal blood vessel of the moth are those of a larva. The intestine which becomes imaginal as a whole and undergoes a certain regress, is of a mixed character: the short, wide oesophagus, the crop which is not sharply defined, and the cylindrical midgut partly retain the traits peculiar to the larva, but the proctodeum and the Malpighian tubes become fully imaginal. The eye spots in an imago are insignificant rudiments of the anlage of the compound eye, rather than of the ocelli proper. The sexual system alone assumes an entirely imaginal character and is involved in a progressive vigorous development.

These changes in the ontogenesis of the female, diverging from the normal development of the male, lead to a transformation of the female into a sac stuffed with eggs (Schranck); they begin in the caterpillar with the aberration in the imaginal development of the wing-buds, resulting in a whole chain of disturbances of morphogenetic correlations which are maintained in the male.

Because of an arrest in the development of the imaginal wing-buds in the female larva, by the end of its larval life those anlages become rudiments corresponding

in their development to the first instar or to the beginning of the second. In their quality of rudiments they produce no morphogenetic stimulus upon the development of the other system of thoracic organs. In the prepupal instar when those morphogenetic correlations are being formed which in the male are responsible for the development of a winged insect, in the female the rudiments of the imaginal wing-buds are passive, and they vanish altogether at early pupal instar.

The female's failure to develop pupal wings results in a non-occurrence of those complex morphogenetic processes which in the male lead to a formation of a thorax of a winged insect, *viz.* there is no development of the wing muscles, no reconstruction of the trachaeal system which is connected with the development of wings; the thoracic legs with their muscles are reduced, the skeleton of the thorax and the musculature of its walls fail to differentiate. The differentiation of the thoracic ganglia comes to a standstill, the development of the tracheal system is simplified, *etc.*

The fact that the female's ontogenesis is lacking processes of the thorax' morphogenesis tells also on the development of the head and abdomen. There is an arrest in the development of the head, of the compound eyes, brain, antennae; the resorption of ocelli is delayed, no differentiation of nerve, tracheal, muscular and blood-vessel system of the abdomen takes place, *etc.* As a result of these deviations in the female's ontogenesis (total reduction of wings and strong regress in the development of thoracic legs), the segmentation of the female's body from a more complete, heteronomous, consisting of an anterior division (head and thorax) and a posterior (abdomen), becomes homonomous. The ventral nervous system retains, similar to that of the larva, the whole of its eight abdominal ganglia, which has been found as early as by Hoffmann, whereas even in the most primitive *Lepidoptera* the number of such ganglia never exceeds five.

Somewhat apart stand ontogenetic processes which lead to an extreme reduction of those mouth parts whose regress in the female, being due, like in the male, to the aphagia of the imago, in the phylogenesis undoubtedly preceded the reduction of the wings and of the systems related with the latter.

We still ignore the nature of the standstill which takes place in the development of the imaginal wing-bud, and the nature of the rest of important deviations in the ontogenesis, owing to which female imagoes retain a number of features peculiar to larvae. Experimental work is necessary to inquire into this phenomenon. But this standstill may possibly be due to a lack or stop of the activity of the hormone of metamorphosis in female larvae.

It is only the reproductive system of the female that undergoes complete metamorphosis; this system is characterized by an extremely vigorous development of the ovary, which is, however, intimately related with the results of the deviations in the ontogenesis discussed above. In the female all the systems of organs give way in the ontogenesis to the ovary whose vigorous development consumes the total material preserved, owing to the standstill in the development, the missing out of metamorphosis, the reduction and histolysis of many systems and tissues.

The imaginal hypodermis of the female spends very little material as compared to that of the male, for it forms a very thin chitin, almost lacking pigment or hairs. An important economy in material is attained owing to: the missing out of the formation of a compound thorax and the simplification of the segmentation and structure of the body; the underdevelopment of the head and its sensory organs; the reduction of the mouth parts and head appendages, and of thoracic legs without preceding metamorphosis; the incomplete transformation of the alimentary canal; the destruction of a part of the larval musculature; the arrest in the development of a number of internal organs which remain in a larval state; the early arrest in the development of the wings, followed by a complete atrophy of the latter. Owing to this, the large amount of the fat body which is spent during metamorphosis by the male is not only spared by the female, but some more material is accumulated at the expense of the histolysis of those organs which undergo reduction. All this material is spent on the development of a vigorous ovary which

leads to a transformation of the female into a short-lived (1—3-day-long) reproductive stage, deprived of any of the main features of an active insect.

The imaginal instar of the bag-worm moth we are dealing with in this paper is reduced to a minimum. It is the larval stage, lasting from two to three years, which is its active instar. Migration, settling at a new territory, struggle for existence, all this is brought about by the larvae. Most of the internal organs and part of the external ones, which are necessary for the active life, are useless for the female imago which upon hatching does not abandon the case of the larva. Hence it is easy to understand the importance of the regress of most of the imago's organs by way of reduction, and the disturbance of most of the fundamental morphogenetic relations in the ontogenesis, and the stabilization of the regress in the phylogenesis. No less easy it is also to appreciate the evolutional value of the deviations in the ontogenesis of the female bag-worm moth, in particular the missing out of some organs, for, owing to the economy of material, an unusually opulent development of the ovary is thus attained, which is highly advantageous for the species' preservation. In fact, this form is widely distributed and biologically progressive.

If we were to judge by the ontogenesis of the female in whose organization regressive features are prevailing over features of neoteny, it might be inferred that in the course of evolution this form will ultimately become mature and fertilized in the larval stage, like the Java beetle, for example.

By comparing the mechanisms of ontogenesis in the bag-worm moth described with that of *Operophthera brumata* L. (Fedotov, 1940), we reveal entirely different regularities in the ontogenesis of the two species. The organs which undergo reduction in *O. brumata* and *Erannis defoliaria* showing a much lower degree of regress than *P. unicolor*, *viz.* the proboscis, wings and some other, are imaginal organs. They go through a long development in the ontogenesis, and it is not until the late pupal instar, after their transformation into imaginal organs, that they undergo incomplete regress. In *P. unicolor* not only a number of the female's organs, but also the mouth parts of the male are subject to regress in larval condition, without passing through metamorphosis.

In the bag-worm moth of the genus *Fumea*, the females of which are less degraded (data by Yezhikov), the reduced organs, inclusive of the wings, are imaginal. In this insect the reduction of wings, being achieved within the pupal instar, embraces, however, with one of its stages the larval instar, similar as in *P. unicolor*. The rest of organs undergo reduction like in the winter-moth, passing through metamorphosis in the pupal instar.

The two types of regress of organs in insects, *viz.*: 1) a regress occurring at later stages of ontogenesis, with preliminary transformation of the organs into imaginal ones, and 2) a regress occurring at earlier stages, without transformation, are not sharply delineated from each other. They are obviously dependent on the various degree of reduction in the imago and on the different historical course of appearance of the regress. We have every ground to believe that the regress among *Psychidae*, highly peculiar *Lepidoptera*, is phylogenetically much older than among the families of *Geometridae*, typical *Lepidoptera* among which belong *Operophthera brumata* L. and *Erannis defoliaria* Cl.

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ENTOMOLOCY

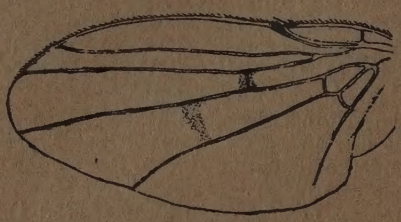
TURANODINIA COCCIDARUM GEN. SP. NOV. *(DIPTERA, ODINIIDAE)*, A NEW PREDATOR OF *PSEUDOCOCCUS COMSTOCKI* KUW. *(HOMOPTERA, COCCODEA)*

By A. A. STACKELBERG

(Communicated by E. N. Pavlovsky, Member of the Academy, 26. XII. 1943)

When working on *Pseudococcus comstocki* Kuw., the Station for Plant Protection in Tashkent bred a number of species of *Diptera*, which develop on adult of *Pseudococcus comstocki* or on the egg-masses of the latter. Amongst those *Diptera*, a new genus of the family *Odiniidae* has been discovered.

In the fauna of the world, the family *Odiniidae* is represented by a small number of species (about 12), belonging to 5 genus. Only 2 genus were up to the present time known from the Palaearctic region: *Neoalticomerus* Hendel (with one species) and



Odinia R. D. (with two species). Both genera are not closely related. The new genus *Turanodinia*, gen. nov., is allied to *Odinia*, but differs conspicuously from the latter by the absence of the posterior cross-vein (see figure).

The following table may serve for the determination of the genera and species of the family *Odiniidae* of the Palaearctic region.

1 (2). Mesopleura hairy, with 2 bristles on posterior margin. 4 dorsocentral bristles. Postvertical bristles not strong. Tibiae with one preapical bristle.

Neoalticomerus formosus Lw.

Middle and North Europe; USSR: Leningrad region (vic. Luga: Stackelberg), Ussuri land (Vladivostok: Stackelberg). The flies occur on the trunks of trees.

2 (1). Mesopleura bare, without hairs or bristles. 5 dorsocentral bristles. Postvertical bristles strong. Tibiae without praeapical bristles.

3 (4). Posterior cross-vein absent; instead of posterior cross-vein a large dark spot formed by very dense microtrichia (see figure). Acrostichal bristles quadriserial. Middle tibiae with only one apical spur.

Turanodinia coccidarum gen., sp. n.

Uzbekistan, Middle Asia, vic. Tashkent. Larva in egg-masses of *Pseudococcus comstocki* Kuw. (*Homoptera, Coccodea*).

4 (3). Posterior cross-vein present. Acrostichal bristles 6—10-serial. Middle tibiae with some apical spurs.

5 (6). Acrostichal bristles 8—10-serial. Cross-veins broadely infuscated.

Odinia maculata Mg.

Europe: N. America; USSR: Leningrad province (Stackelberg).

6 (5). Acrostichal bristles 6-serial. Cross-veins narrowly infuscated.

Odinia boletina Zett.

Europe; N. Africa; N. America; USSR: Leningrad province (Stackelberg)

TURANODINIA, gen. nov.

Frons broad. Frontal stripe with sparse hairs. Vertical plates reaching to the front margin of frons. Postvertical bristles strong, diverging. Outer and inner vertical bristles strong. Two strong reclinate orbital bristles. One frontal bristle (ori) medially directed. Lunula large, without hairs. Antennae moderately large, third antennal joint ovate, a little pointed. Arista bare. Face concave, without longitudinal ridge. Praelabrum not distinct. Peristomal bristles distinctly developed. Vibrissae strong. Mesonotum with 5 dorsocentral bristles. Acrostichal bristles moderately small, quadriserial. 1 humeral, 1 posthumeral, 2 notopleural, 1 supraalar and 1 postalar bristle, intraalar bristles 3—4; scutellum with 4 marginal bristles. Sternopleural bristles 3; lower part of sternopleura hairy. Tibiae without praeapical bristle. Hind femora in the apical third with one strong bristle below. Middle tibiae with one apical spur. Hind femora, tibiae and tarsi broadened. Venation normal. Costal vein reaching to r_{4+5}, with one excision at r_1. Posterior cross-vein not developed; instead of posterior cross-vein a large dark spot formed by very dense microtrichia. Anal cell present.

Typus generis: *Turanodinia coccidarum*, sp. n.

Turanodinia coccidarum, sp. n.

Head moderately large, pale. Frons broad, about twice as broad as one eye; frons yellow; orbits and vertical triangle pale greyish. Face pale brownish-yellow above, whitish below. Eyes ovate, nearly twice as long as broad. Palpi yellow. Antennae dark yellowish, third antennal joint slightly darker above and at tip; third antennal joint ovate, about 1.25 times as long as broad, a little pointed. Thorax pale greyish; scutellum with yellowish hind margin. Pleura pale greyish with two dark longitudinal stripes, superior reaching from humeral callus to wing base and inferior one reaching from anterior coxae to halteres. Abdomen pale ashy-grey, with small dark points on the bases of hairs and large, but not sharply defined dark lateral spots on the third, fourth and fifth tergit. Abdomen with not dense, but moderately long pale yellow hairs. Abdomen pale greyish below. Legs pale yellow, robust. Basal half of hind coxae darkened. Front femora with a row of moderately long postero-ventral bristles, posteriorly in the apical half with a more or less distinctly developed dark spot. Middle and hind tibiae with a broad dark ring in the middle and with narrow dark ring at base and at tip. Hind femora below on the base of strong bristle with a more or less developed dark spot. Wings (see figure) hyaline, veins yellow; r_1 in the middle, r_{2+3} and r_{4+5} at base, r_{2+3}, r_{4+5}, m and cu at tip distinctly darkened. Anterior wing-margine at tip of r_1 with moderately large dark spot. Anterior (middle) cross-vein with a moderately broad brownish seam. Instead of posterior cross-vein a large dark spot formed by very small, but dense dark microtrichia. Squamulae yellowish white with a long dark fringe. Halteres yellowish white. Length 1.5 mm.

Distribution. Uzbekistan, Middle Asia, vic. Tashkent, 14.VIII.1943. 1 ♂ reared from the egg-masses of *Pseudococcus comstocki* Kuw. (*Homoptera, Coccidae*). Type in the collection of the Zoological Institute, Academy of Sciences, Leningrad.

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